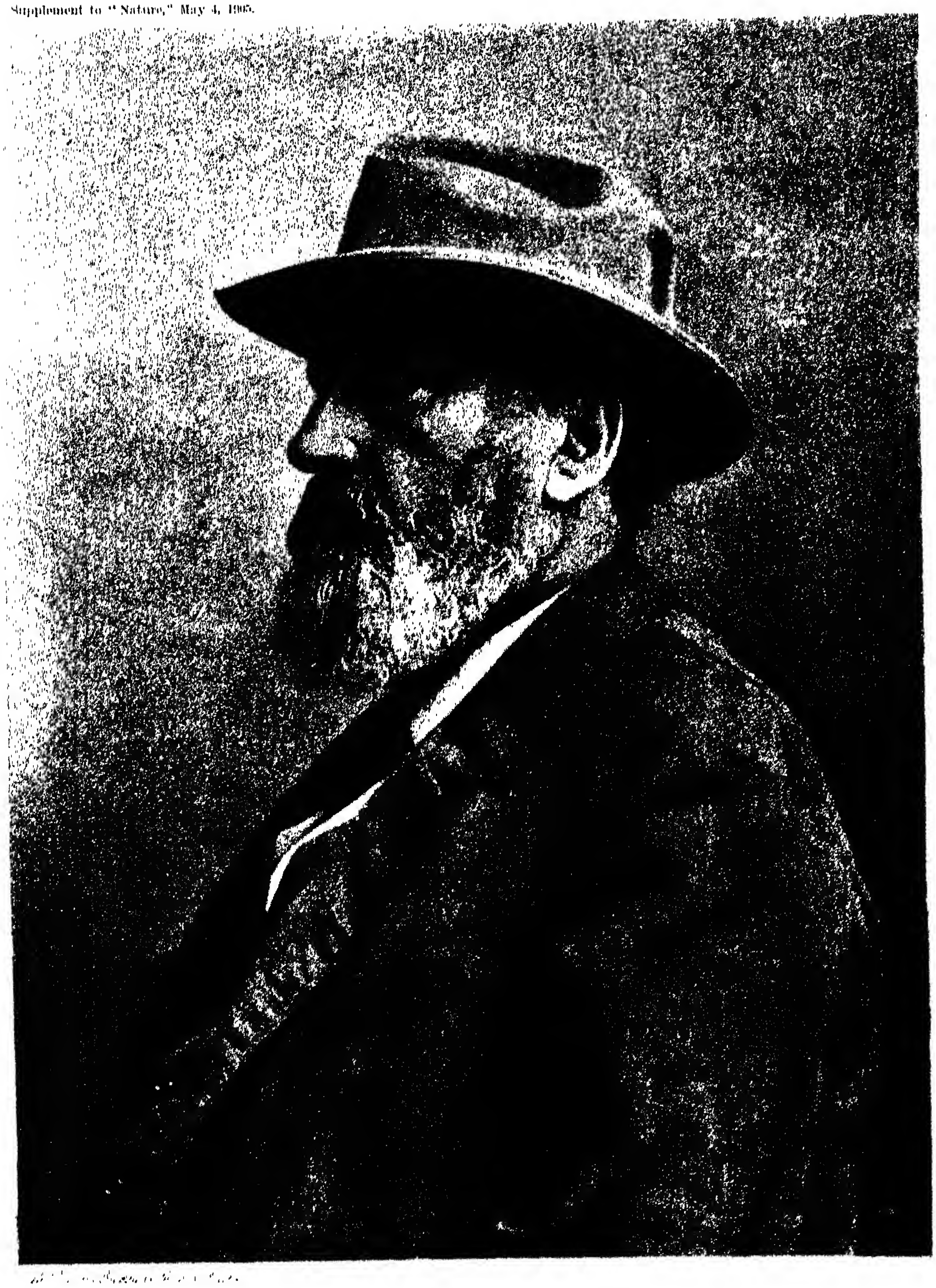

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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH

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NATURE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MAY 4, 1905.

SCIENTIFIC WORTHIES.

XXXV.—EDUARD SUESS.

AMONG the living leaders of geology none is more widely known and more highly honoured than Eduard Suess. The amount and value of his original contributions to science, the broad, philosophic grasp he has displayed of every department of research on which he has entered, the vivid, imaginative insight which has enabled him to marshal a multiplicity of scattered facts into connected order and sequence, the unwearied industry with which he has made himself acquainted with the geological literature of almost every country on the face of the globe, and the noble march of the literary style in which he has clothed not a little of his reasoning and speculation, have combined to give him a place apart, like that of one of the great masters in the heroic age of geology. Full of years and honours, and president of the Academy of Sciences, he still moves as the centre of the scientific life of Vienna, still enriches the world with his impressive pictures of the structure and history of the earth, and still manifests an ardent interest and enthusiasm in all that concerns the advancement of natural knowledge.

But for a wave of change in the world of commerce we might have claimed Suess as an Englishman, and his achievements might have added their lustre to the scientific fame of this country instead of Austria, for he was born in London and spent here the earliest years of his childhood. His father, who was a native of Saxony, had settled here as a German merchant, importing wool from Bohemia, and it was during the residence of the family in London that the eldest son and future geologist was born on August 20, 1831. When wool began to arrive in abundance from the vast sheep-runs of the Australian colonies, the trade in the Bohemian product declined so much that at last, in November, 1834, the Suess family left England for Prague. The father in 1845 became a partner in a great industrial establishment in Vienna, and that city was thenceforth the family home. It had been at first intended that the son should enter the same business, and accordingly at the end of the usual school training he was placed in the polytechnic school. But it soon became apparent that his natural bent did not lie in the commercial direction, but wholly towards natural history studies. As early as the year 1850, when he was only nineteen years of age, he ventured upon his first publication—a short sketch of the geology of Carlsbad and its mineral waters, specially prepared for the use of foreigners. So completely had his tastes now decided his future life that in the following year he was appointed an assistant in the Imperial Museum of Vienna, and thus made his formal entry into the official ranks of science. From that day until now the long intervening half-century, though uneventful in personal experiences, has been with him a time of ceaseless industry and fruitful research. A few more specially notable epochs in his career may here be noticed.

In the vast palæontological collections of the Vienna Museum Suess found a wide domain for the exercise of his powers of observation and comparison. He at first specially devoted himself to the study of the brachiopods of the Palæozoic and Mesozoic formations, and for some ten years continued to publish the results of his researches among these interesting and important fossils, but with incursions into other departments of the animal kingdom, which displayed a general enthusiasm for biological inquiry from the geological point of view. His zeal and ability were soon recognised by his being appointed in 1857, at the age of twenty-six, professor in the university. In 1862 he relinquished his post in the museum and devoted himself thenceforth to the duties of his chair. It was in this early part of his life that he entered upon those studies in palæogeography on which his scientific renown

now largely rests. As far back as 1863 he published a brief statement of the results to which his inquiries had led him as to the former connection of northern Africa with southern Europe. In 1855 he married the daughter of Dr. Strauss, a distinguished physician in Prague, and then entered on a life of great domestic happiness, which largely contributed to the success of a strenuous career wherein science and politics came to be strangely blended.

From his youthful days, when he described the Carlsbad springs, he had been interested in underground waters, and among the inquiries which he pursued while attached to the museum was one that embraced the relations of the soil and water supply of Vienna to the life of its inhabitants. In 1862 he published a small volume on this subject,[1] in which he gave a comprehensive account of the economic geology of the district. At that time the city was suffering from an impure water supply and consequent typhoid fever. The luminous essay of the young professor at once attracted attention. He was the same year elected into the town council, that he might give the benefit of his advice in the steps to be taken towards the attainment of better sanitary arrangements. He boldly advocated a scheme for bringing the abundant pure water of the Alps into Vienna by means of an aqueduct 110 kilometres in length. This project, eventually adopted, was brought to a successful termination in 1873. So grateful were his fellow-citizens for the signal service thus conferred on them that they bestowed on him their highest civic distinction by electing him an honorary burgess. By this time he had made his mark in the town council as one of its most useful and able members, so that it was not surprising that he should have been chosen as one of the parliamentary representatives. For more than thirty years he sat in the Austrian Parliament as a powerful leader of the Liberal party, only retiring in 1896, when advancing age made the strain of the two-fold life as a politician and man of science too great to be longer borne. When the political history of the country during the last half of the nineteenth century comes to be written, a prominent place in it will be given to Eduard Suess.

But it is his scientific work that has to be chiefly dwelt upon here. As an enthusiastic and able teacher he has exerted a notable influence on the successive generations of students at the university, until after forty-four years he resigned his professorship in the summer of 1901. Throughout his career he has shown a keen interest in those branches of geology which more especially deal with the evolution of the earth's surface features. The problems of mountain-building were suggested to him by his excursions among the eastern Alps, and in 1875 his views were so far matured that he published a little volume entitled "Die Entstehung der Alpen." This work contains the germ of those later contributions to science which have placed him on so conspicuous an eminence among the geologists of the day. It sketches the general principles of mountain-architecture, especially revealed by a study of the Alpine chain. But he did not confine his view to the particular area with which he was himself personally familiar. Already his eye looked out on the wider effects of the unequal contraction of the terrestrial crust, and swept across the European continent eastwards into Asia, and westwards across the Atlantic into America. He still held the general belief in the upheaval and depression of continental areas, and dwelt on the evidence of these movements in Scandinavia, which he has since rejected with much elaboration of argument. To thoughtful students of the science this treatise, in its firm hold of detail combined with singularly vivid powers of generalisation, was full of suggestiveness. But the interest and importance of its subject did not obtain general recognition until it was followed ten years afterwards (1885) by the first volume of the great "Antlitz der Erde"—the work which has chiefly given Suess his place among his contemporaries, and by which his name will be handed down to future time.

In its striking arrangement of subjects, in its masterly grouping of details which, notwithstanding their almost bewildering multiplicity, are all linked with each other in leading to broad and impressive conclusions, and in the measured cadence of its finer passages, the "Antlitz" may be regarded as a noble philosophical poem in which the story of the continents and the oceans is told by a seer gifted with rare powers of insight into the past. The order of treatment is not that of a systematic text-book. On the contrary, the casual reader who looks over the contents of the chapters might suppose them to consist of a series of desultory essays with no very clear sequence of thought. Yet a more leisurely study soon shows him how closely interwoven is the texture of the whole composition. He is astonished at the almost incredible range of literature which the author must have consulted, and he finds himself borne onward page after page by the luminous array of facts and the brilliant conclusions drawn from them. From the ancient traditions of the Deluge he is led through other human records, and made to see by what combination of physical conditions changes are worked on the surface of the earth. Upheaval and subsidence, volcanic eruptions, the elevation of mountain-chains, the depression of sea-basins, the structure and disposition of continents, the formation and boundaries of the different oceans in the past as well as at the present day, the successive plications that in the course of geological time have produced the land areas and mountain-ranges of the globe—in short, the gradual evolution of the existing topography of the surface of the globe—this vast theme is here treated with a fulness of knowledge and a breadth of view which are to be found in no other author.

The work at once commanded attention among the geologists of every country, and the influence of its

[1] "Der Boden der Stadt Wien nach seiner Bildungsweise, Beschaffenheit, und seinen Beziehungen zum Bürgerlichen Leben." (Vienna, 1862.)

teaching before long became apparent in geological literature. It was first translated into French in an edition which, thanks to the singular erudition of its editor, M. E. de Margerie, has been so enriched with footnotes as to become an invaluable work of reference for published papers in every department of the wide range of subjects whereof it treats. Within the last few months the first volume of an English translation by Miss Hertha Sollas, under the direction of her father, Prof. Sollas, of Oxford, has been issued by the Clarendon Press. The labours of Prof. Suess are thus placed within the reach of all English-speaking geologists in a version which reads more like an original treatise in our language than as the translation of a German work.

That in covering so wide a field as that of the "Antlitz" the author has necessarily had to rely on recorded observations of unequal value, and that consequently the deductions he has drawn may need to be corrected from subsequently obtained fuller and more accurate data, will doubtless be admitted by no one more frankly than by himself. But even in regard to questions which have long been discussed, and regarding which abundant facts have long been known, there is room for different interpretations from those which the professor has adopted. Thus the phenomena of submergence and emergence of land in Sweden and the basin of the Baltic are treated by him in great fulness and with much ingenuity, but he arrives at conclusions strongly opposed to those to which prolonged study has led the northern geologists. This problem is one of fundamental importance in regard to our conceptions of the nature of the movements to which the surface of the globe is subject, and it is much to be desired that some general agreement in regard to it should be attained.

Nevertheless, apart from differences of opinion, which are inseparable from the growth of such a science as geology, and even where one may be most disposed to dissent from the views of Prof. Suess, the transcendent value of his life-long labours is none the less vividly realised now by all who have studied his writings. Their importance in the history of science will assuredly be no less fully acknowledged by the future generations who will gain from them inspiration and enlightenment. Meanwhile, he has the satisfaction of abundant recognition from all civilised countries. The learned societies of Europe have vied with each other in doing him honour, and not the least prominent among them has been our own Royal Society, which ten years ago elected him as one of its foreign members, and in the year 1903 awarded him the Copley medal—the highest distinction which it has to bestow. The "Antlitz" is not yet completed, but the second part of the third volume is far advanced. Let us trust that years of rest and quiet work are in store for the illustrious geologist, and that he may live to finish his work amidst the hearty congratulations of the many fellow-workers who look up to him as their master.

ARCH. GEIKIE.

THE RUDIMENTS OF BEHAVIOUR.

Contributions to the Study of the Behaviour of Lower Organisms. By Prof. Herbert S. Jennings. Pp. 256. (Washington: Carnegie Institution, 1904.)

THE author has been for about ten years a careful observer of the rudiments of behaviour which are exhibited by unicellular and other relatively simple animals, and we have read with interest several of his previous studies on the reactions of infusorians and the like to various sets of stimuli. The general impression conveyed was that infusorians and the like gave evidence of an exceedingly simple and stereotyped mode of behaviour—a mere reaction method. When effectively stimulated by agents of almost any kind, the animalcule moves backwards and turns to a structurally defined side of its minute body, while at the same time it may continue to revolve on its long axis. In relation to all sorts of stimuli, the behaviour seemed exceedingly simple and machine-like. But Prof. Jennings has been gradually discovering that the simple reaction-formula does not cover all the facts, and he now gives us news which seems almost too good to be true.

He finds that even among unicellulars "the behaviour is not as a rule on the tropism plan—a set, forced method of reacting to each particular agent—but takes place in a much more flexible, less directly machine-like way, by the method of trial and error." This is a momentous conclusion, notably in relation to comparative psychology. The data are foundation-stones for the science of animal behaviour, and the author is to be congratulated on his demonstration that the ways of even very simple creatures are more than series of "tropisms."

In his "Introduction to Comparative Psychology" (1894), Dr. Lloyd Morgan told the story of his dog's attempts to bring a hooked walking stick through a narrow gap in a fence. The dog "tried" all possible methods of pulling the stick through the fence. Most of the attempts showed themselves to be "error." But the dog tried again and again, until he finally succeeded. He worked by the method of trial and error; and so, Prof. Jennings now assures us, do the infusorians.

"This method of trial and error involves many of the fundamental qualities which we find in the behaviour of higher animals, yet with the simplest possible basis in ways of action; a great portion of the behaviour consisting often of but one or two definite movements, movements that are stereotyped when considered by themselves, but not stereotyped in their relation to the environment. This method leads upward, offering at every point opportunity for development, and showing even in the unicellular organisms what must be considered the beginnings of intelligence and of many other qualities found in higher animals. Tropic action doubtless occurs, but the main basis of behaviour is in these organisms the method of trial and error."

This is not the first time that the dawning of intelligence has been discovered in the Protozoa, but on previous occasions the discovery has been reported by casual observers or by investigators unacquainted with the tropisms. Prof. Jennings has made a special

study of the tropisms, and we find him declaring that it is almost impossible to describe the behaviour of the unicellulars intelligibly without using terms like "perception," "discrimination," and "intelligence." Of course these are used in an "objective sense," and "when their objective significance is kept in mind there is no theoretical objection to them, and they have the advantage that they bring out the identity of the objective factors in the behaviour of animals with the objective factors in the behaviour of man."

From our point of view, Prof. Jennings does not strengthen his position by using these pre-occupied psychological terms; "'perception' of a stimulus," he says, "means merely that the organism reacts to it in some way; 'discrimination' of two stimuli means that the organism reacts differently to them; 'intelligence' is defined by the objective manifestations mentioned in the text." But this does not seem to us the sound line of progress; it leads back to saying that the lucifer match perceives the sandpaper on the box. It seems safer, in the meantime, to say that infusorians alter their behaviour, and alter it effectively, in respect to their experience.

"Stentor does not continue reacting strongly to a stimulus that is not injurious, but after a time, when such stimulus is repeated, it ceases to react, or reacts in some less pronounced way than at first. To an injurious stimulus, on the other hand, it does continue to react, but not throughout in the same manner. When such stimulus is repeated, Stentor tries various different ways of reacting to it. If the result of reacting by bending to one side is not success, it tries reversing the ciliary current, then contracting into its tube, then leaving its tube, &c. This is clearly the method of trial and error passing into the method of intelligence, but the intelligence lasts only very short periods."

With such difficult subjects any evidence of the registration of experience was not to be expected, and the author is to be congratulated on having discovered considerable evidence in support of the thesis that the behaviour of unicellulars is largely a method of trial and error, one reaction by trial and error becoming the basis for a succeeding reaction. This is surely a pathway leading to the high-road of intelligence.

It is easy to make an inanimate system—a little potassium pill on a basin of water, or a tiny wound-up engine on a smooth table—which, once set a-going, will charge against an obstacle, will fail to overcome this, will recoil passively and charge again, and some observers have thought that, *mutatis mutandis,* the animalcule did little more. But Prof. Jennings has shown that the infusorian, in relation to its experience of "error," changes its little tactics, and changes them again, until it succeeds. In a word, it profits by experience. The very essence of vitality, as Spencer pointed out, is in effective response to environment; but when we find an infusorian "trying" one response after another, abandoning those that spell "error," we cannot but feel that vitality has been raised to a second power; it is just beginning to be intelligent. The infusorian is more than a tropic automaton, it is playing a little game of tactics; perhaps if we could educate one it would develop the rudiments of strategy. It is, of course, extremely difficult to keep to a scrupulous objective record of what occurs, but we incline to think that Prof. Jennings has supplied what comparative psychologists have been waiting for, namely, quite trustworthy accounts of the beginnings of selective or controlled behaviour.

"The method of trial and error involves some way of distinguishing error, and also, in some cases at least, some method of distinguishing success. The problem as to how this is done is the same for man and for the infusorian. We are compelled to postulate throughout the series certain physiological states to account for the negative reactions under error, and the positive reactions under success. In man these physiological states are those conditioning pain and pleasure. The 'method of trial and error' is evidently the same as reaction by 'selection of over-produced movements,' which plays so large a part in the theories of Spencer and Bain, and especially in the recent discussions of behaviour by J. Mark Baldwin. The method of trial and error, which forms the most essential feature of the behaviour of these lower organisms, is in complete contrast with the tropism schema, which has long been supposed to express the essential characteristics of their behaviour."

Instead of referring in detail to the author's studies—(1) reactions to heat and cold in the ciliate infusorians; (2) reactions to light in ciliates and flagellates; (3) reactions to stimuli in certain rotifers; (4) the theory of tropisms; (5) physiological states as determining factors in the behaviour of lower organisms; and (6) the movements and reactions of amœbæ—we have sought to explain the chief result of his studies in the infant school of life, and to emphasise its importance in relation to the general theory of animal behaviour. Prof. Jennings has rescued the animalculæ from the bonds of automatism too hurriedly thrust on them, and has afforded a secure basis for the study of the evolution of intelligence.

J. A. T.

MECHANISM.

Mechanism. By Prof. S. Dunkerley. Pp. vi+408. (London: Longmans, Green and Co., 1905.) Price 9s. net.

WRITERS of text-books on mechanism have, of late years, been much influenced by the views of Realeaux on the classification of mechanisms, and the present work shows clearly the impress of these views; but the author has not hesitated to depart from the order in which Realeaux presented his theory of machines in order to suit the needs of beginners, who are apt to find the elaboration of the systematic theory somewhat dry if not accompanied by a wealth of illustration drawn from actual machines, even if these contain elements the properties of which have not been fully explained.

The author, as appears from his preface, is fully alive to the difficulties which the logical treatment of the subject presents, and he expressly states that his work is not intended to be a philosophical treatise on the subject.

From this standpoint the arrangement of the sub-

ject-matter appears to be quite a proper one, for at the present time almost everyone is familiar with the elementary properties of gear-wheels, clutches, the mechanism of steam engines and the like, because of their increasing use in everyday life, and more especially of late, owing to their applications to self-propelled vehicles. On the other hand their less obvious, although not less important, properties are possibly not so well understood; thus, to take a single instance, the conditions to be satisfied in order to produce true rolling motion by gear wheels require a knowledge of the properties of various curves, and this latter subject may well be left to a later stage, as is done in the present work, although it need not prevent a study of machines containing gear wheels when this knowledge is not absolutely necessary for the purpose. The author has therefore described many machines using higher pairing quite early in the book, and has left the more detailed examination of some of the elements for later chapters; this adds very much to the general interest of the reader, while its drawbacks are small. The work opens with an introductory chapter in which the usual definitions occur relating to machines, kinematic chains, lower and higher pairs, and the like, and this is followed by a chapter which is exceedingly interesting on simple machines and machine tools.

Chapters iii. and iv. deal chiefly with mechanisms of the quadric crank and double slider crank chain forms, all those possessing important geometrical properties being grouped together. Naturally the pantograph finds an important place here, and to amplify this section there are descriptions of the copying lathe and also a machine on the same principle for drilling square and hexagon holes. In a future edition it might be worth while to insert, in a suitable place, an account of the epicyclic trains which form an essential part of some machines for turning nuts and bolts to a practically perfect square or hexagon section.

The next two chapters deal with velocity and acceleration diagrams, and we are sure that all students of mechanism will feel greatly indebted to the author for the clear manner in which he has presented this part of the subject. The remainder of the book deals with gear wheels, non-circular wheels and cams, and these are discussed on the usual lines. There is also a section devoted to gear-cutting machinery, which gives an interesting account of this special branch of machine tool work.

It is somewhat remarkable that no place is found in the book for the consideration of so fundamental a subject as the degrees of freedom possessed by a body and the applications which follow from a recognition of these principles in geometrical slides and clamps, such as are described in Thomson and Tait's "Natural Philosophy." Ignorance of these fundamental principles has been one of the most fruitful causes of bad design in mechanism.

The illustrations are mainly line drawings, exceedingly well adapted for descriptive purposes, and with a few exceptions the photographs of machinery are clear and distinct. A series of numerical examples at the end of the book will be of much value to students.

The author has succeeded in writing a valuable text-book on mechanism which will repay a careful study by engineers and others who wish to obtain a knowledge of something more than the elements of this branch of science.

E. G. C.

PRACTICAL ELECTROCHEMISTRY.

Practical Methods of Electrochemistry. By F. Mollwo Perkin. Pp. x+322. (London: Longmans and Co., 1905.) Price 6s. net.

ELECTROCHEMICAL methods, both of analysis and preparation, have in recent years undergone such rapid development, and have reached such a degree of importance, that systematic instruction in their employment has become an indispensable part of the training of the modern student of chemistry. This book, therefore, forms a welcome addition to the ordinary laboratory manuals.

After a general account of electrical magnitudes and units, measuring instruments, and electrolytic apparatus, the author gives practical instructions for electrochemical analysis. The conditions for the quantitative electrodeposition of the individual metals are first discussed; then follows a section on quantitative oxidation and reduction at the electrodes, and, finally, directions are given for the separation of metals from mixed solutions of their salts. The last and longest section of the book deals with preparative electrochemistry. The primary subdivision of the subject is into the preparation of inorganic and of organic compounds, the latter section being treated in three chapters on organic electrolysis, reduction of organic compounds, and oxidation of organic compounds respectively.

The practical instructions are on the whole adequate and accurate, so that the student could acquire with little assistance a sufficient acquaintance with the working methods of electrochemistry. Whilst the book is satisfactory in this, the most important, feature, it shows in other respects many signs of hasty composition, which greatly detract from its value. For example, there are frequent evidences of haste in the treatment of electrical units. In the table on p. 9 the heading of the last column but one is "electrochemical equivalent per coulomb in mg. per sec."; the words "per sec." are not only superfluous but misleading. On p. 29 we find "1 kilowatt=101.93 kilogrammeters," and "1 horse-power is 75 kilogrammeters," where the words "per second" should have been added in both cases. Nothing is more detrimental to clear thinking on the part of the student than slipshod statements of this kind. Again, in the table of "useful data" on p. 286 we find "1 kilowatt=1000 watt-hours," and "volt × amperes=watts." Such data are the reverse of useful. A curious batch of mistakes is to be found on pp. 231–232. It is stated on p. 231 that the electrolyte for the preparation of diethyl succinate is "*acid* potassium or sodium malonate" instead of "*ethyl* potassium or sodium malonate." On the same page we twice find "*diethyl adipic acid*" instead of *diethyl adipate*, and on the succeeding pages a similar error

is repeated. On pp. 226–227 it is surely wrong to ascribe the formation of the trace of ethylene found during the electrolysis of an acetate to the same cause as that which produces the plentiful yield of ethylene during the electrolysis of a propionate. The fact that equation v. is divisible by 2, and that equation iv. is not so divisible, is almost in itself sufficient evidence that the actions are of essentially different character. It is somewhat surprising to find that the kathodic reduction of nitrites, nitrates, and arsenical compounds finds treatment under the heading "Metals deposited as Oxides at the Anode" (pp. 145–150). These and similar slips are minor blemishes; but it is to be hoped that the author will subject his book to a thorough revision for their removal when a second edition is called for.

The references to original papers are numerous, and a convenient table of five-figure logarithms, with instructions for its use, is contained in an appendix. The value of the table might be still further augmented by the inclusion of instructions for the use of the decadic complements of logarithms, a device of which the chemical student is almost invariably ignorant.

OUR BOOK SHELF.

Das Alter der wirtschaftlichen Kultur der Menschheit, ein Rückblick und ein Ausblick. By Ed. Hahn. Pp. xvi + 256. (Heidelberg: Carl Winter, 1905.) Price 6.40 marks.

In the opinion of Dr. Hahn, well known as the inquirer who revolutionised our ideas on the so-called "three stages"—hunting, pastoral pursuits, agriculture—the mass of the reading public will not change its traditional views on pre-history and primitive culture unless the specialist is prepared to do more for it than issue specialist literature. With the object of making propaganda for his views on the domestication of animals, the forms of cultivation, the transition from hoe-cultivation to plough-cultivation, the invention of the plough, the use of the ox as draught-animal, the share of woman in primitive culture, and especially the development of personal property, Dr. Hahn has written the present work, and his object in so doing is commendable. Even specialist literature, however, is not above all considerations of form and logical sequence of ideas; in an *oeuvre de vulgarisation* it is *à fortiori* necessary that there should be an orderly development of facts and of the conclusions to be drawn from them; and this, unfortunately, Dr. Hahn has not given us. Not only is the book in places indigestibly full of facts the connection of which with the main argument is not always made clear, but too much is attempted; to the list of subjects given above must be added the description of the economic conditions and interrelations of China, Babylonia, India, and Egypt, a discussion of the origin of the wheel and the waggon, much polemical matter, dealing with criticisms which the public has never read, and finally excursuses on the fiscal question, socialism, and other subjects unconnected with his immediate purpose. It would be unfair to deny that the book is interesting and stimulating, but it is rather a *causerie* than an exposition of the author's theories. This is the more unfortunate because his views on the domestication of animals, the forms of cultivation, and the stages of economic evolution are largely accepted. From mere lack of literary skill Dr. Hahn will leave his readers comparatively unmoved. As an example of the deficiencies of the book we may mention that the process of domestication of cattle is dismissed with a mention. Many of the author's theories are improbable; it is unnecessary to suppose that the curved horns imitating the shape of the crescent moon first led to the sacro-sanctity of cattle; there are animal cults everywhere. Personal property, even in vegetable food, was known before domesticated plants; the Australian natives store up *bunya-bunya* nuts. We do not need to look to the apparent motion of the stars for the explanation of the origin of Babylonian god-processions, which are a natural method of disseminating the holy influence. The connection of sexual ideas with agriculture may be secondary; syncretism is disregarded in this and other instances. It may not be out of place to say that a few maps of culture areas would have been very helpful, and not to the general reader only.

N. W. T.

Infantile Mortality and Infants' Milk Depôts. By G. F. McCleary, M.D., D.P.H. Pp. xiv + 135. (London: P. S. King and Son.) Price 6*s.* net.

The publication of the evidence before the Inter-Departmental Committee on Physical Deterioration has directed general attention to such subjects as infant feeding. The decreasing birth rate and the appallingly high death rate among infants are dealt with by the author in the earlier chapters of his book.

An increasing number of mothers are unable to nurse their children, so that some method of artificial feeding has to be adopted. The death rate in 1904 among children under one year was 140 per 1000 births, and even these figures by no means represent the total evil, for many of the survivors must be seriously affected. How can this fearful waste of life be stopped? Dr. McCleary deals with one solution, viz. the establishment of depôts worked by the municipality and partially rate-supported. It is generally agreed that cow's milk is the best substitute for human milk. Various opinions are held as to the degree of modification that may be necessary, but pure cow's milk is the *basis* from which to work.

Even if a pure milk were on the market the poor could not afford to buy it. The question of State assistance arises. Dr. McCleary leaves the moral question as to whether it is for the ultimate good of a people to relieve them of their parental duties. Within the compass of 130 pages he wisely restricts himself to the practical working of the depôts, and as he speaks with knowledge of the Battersea depôt his testimony is of interest. In France the milk depôt system is carried out to a considerable extent, unmodified sterilised milk usually being supplied (Budin's method). In America the tendency is to follow Rotch in giving modified unsterilised milk.

The author repeats the necessary warning that a dirty milk is not made clean by sterilisation, and from this it follows that no depôt is on a satisfactory basis unless it has absolute control of its own milk supply. Dr. McCleary advocates much more stringent supervision of the general milk supply, and the establishment of municipal depôts on the lines of that at Rochester, U.S.A.

The book is well illustrated.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Parts i. to v. Pp. iv + 146. (Sydney: W. A. Gullick, 1903–4.)

The classification of the Australian eucalypts presents similar difficulties to those which confront the botanist who undertakes the arrangement of the Hieracia or Rubi of our native flora, with the additional disadvantages that the eucalypts are trees or shrubs, and their distribution is more extensive. In the cir-

cumstances it is natural that monographers should have expressed diverse opinions as to the limits of the species, and that different characters and parts of the plant should have been taken as a basis for classification. Bentham grouped the species according to the shape and mode of dehiscence of the anthers, and von Mueller followed his lead. Prof. Tate has proposed a system based upon the structure of the fruit, whilst of vegetative characters, the cotyledons, leaf-veins, stomata, gums, and timber have all been tested in the hope of finding satisfactory criteria. Mr. Maiden attaches considerable importance to the bark and timber for the guidance of the forester, but recognises that the anthers and fruit are the best characters for the systematist.

In the present monograph the object of the author has been to include, with a description of the important characters, the substance of all recorded observations and investigations which might assist in determining the position and value of species or varieties. Synonyms are considered in detail, with the original description of each where it has been proposed as a species, and the range of each species is noted; finally, the author's views are crystallised in a discussion of the affinities of allied species. These views are based not only on the examination of specimens from important herbaria, but also upon much careful study of the growing trees in their native localities. Whilst recognising the desire of the author to render the work as comprehensive as possible, it must be said that its practical value would be increased by a considerable reduction in the amount of material, in the size of print and in the spacing. The five parts issued amount to 145 pages, and contain twenty-four plates for eight species, so that the complete work will be bulky and exclusive as to price. It may be suggested that a supplement to this treatise in the shape of a compendium suitable for foresters and students generally would be most useful.

Hymenopteren-Studien. By W. A. Schulz. Pp. 147. (Leipzig: Engelmann; London: Williams and Norgate, 1905.) Price 4s. net.

THE present work consists of three essays, the first relating to African Hymenoptera (chiefly Vespidæ and Fossores), the second describing new genera and species of Trigonalidæ, and the third discussing Vespidæ and Apidæ from the Amazons. The work is chiefly descriptive, and will hardly appeal to any but specialists, who must of course consult it when working at the faunas and groups which are discussed in it.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The High-frequency Electrical Treatment.

THE inquest on a lady who died in the Charing Cross Hospital on April 11 must be of interest to those who employ the high-frequency electrical treatment. The report of the case in the *Standard* of April 17 is as follows:—"On April 11 she (the deceased) was under treatment, lying on the electrical couch. Suddenly witness observed the perspiration break out on her face, and immediately stopped the current. He watched her for a while, and as she seemed to be in a collapsed state he administered a spoonful of sal volatile. Then he recognised symptoms which pointed to 'a serious state of affairs,' and sent for Dr. Bailey. The lady was removed to another ward and died in the evening. Death was caused by hemorrhage of the brain, following a rupture of an artery. This was not a consequence of the electrical treatment; she would probably have died just the same if she had been sitting in the waiting-room, instead of on the electrical couch. It was a mere coincidence. Dr. Bailey and Dr. Freyberger gave evidence supporting this view of the case." The treatment was that of the high-frequency electrical current.

Now that high-frequency electrical discharges are much employed in medical work, being the newest and most up-to-date method of treatment for many diseases, it is somewhat important that even "mere coincidences," such as that cited, should not be overlooked or treated lightly; it is only by collecting evidence on such points that any real knowledge respecting the action of the treatment can be obtained. Shortly after the experiments of N. Tesla on electrical discharges, I carried on many experiments on the subject, and from somewhat painful experience I have learned that one source of trouble may be overlooked by many, since it is a secondary action, so that while the utmost attention may be given to the behaviour of the discharge itself, but little may be given to the action of the air which has been subjected to an electrical discharge. The danger of breathing such air was pointed out by me long ago (NATURE, 1896), and by many other workers with electrical discharges since then. Air which had been acted on by the high-frequency discharge, when breathed, caused irritation to the throat and lungs, and a feeling of suffocation, in some cases very severe. This is rather to be expected, since ozone and ozonised air act on blood, albumen, and organic substances readily. Profs. Roscoe and Schorlemmer write thus in their treatise on "Chemistry," p. 243, vol. i. (subject, ozone):—"Whilst blood is completely decolorised, the albumen being entirely, and the other organic matters being nearly all destroyed.")

The trouble mentioned was removed to a considerable extent by inducing a strong draught of warm air across the chamber where the apparatus was used. I feel that I am taking a great liberty in suggesting anything to the high-frequency specialist, who will give me at once the reason why self-induction is expressed as "a length," and why a rapidly varying electromagnetic field causes flashes of light to be seen when the head is placed in such a field. I would suggest that in connection with the method of treatment with the high-frequency discharge, all evidence of new phenomena should be collected and sifted in a scientific spirit, whether it be for or against it.

Operators now take every possible precaution to guard themselves against the evil effects of the X-ray, which at first was treated as quite innocuous. May not the high-frequency discharge in a modified form have a somewhat similar kind of action, and should it not be treated with as much, or at least some, caution?

F. J. JERVIS-SMITH.

The Critical Temperature and Pressure of Living Substances.

IT is well known that living substance is in a labile state, its constructive or destructive metabolism being determined by minute changes, sometimes of temperature or pressure, sometimes of other dynamic conditions. But Mr. Geoffrey Martin's suggestion (NATURE, April 27, p. 609) that the lability is due to the great number of atoms in the molecules of living substance, or to the complex "carbon compounds" present, gives only a partial explanation.

The decomposition of a chemical compound under raised temperature, diminished pressure, &c., depends not only on the size and complexity of the molecules, but also on the tendency of the atoms to re-arrange themselves and form more stable compounds, generally with dissipation of energy. For instance, the paraffins with large molecules are fairly stable, the products of their decomposition being hydrocarbons still. Fatty acids with equally large molecules are less stable, for there is a tendency to split off substances of higher oxidation, leaving a hydrocarbon residue. This tendency increases with the increase of oxygen in compounds, and so the small molecule of glucose is less stable than the large molecule of fatty acid. The presence of nitrogen is often a cause of instability, especially when the nitrogen forms a link between elements (or groups) of opposite polarity; and the instability is most marked when the nitrogen is combined with oxygen on the

one hand, and with carbon and hydrogen on the other, as in the explosives, *e.g.* nitroglycerine.

Living substance has apparently all the above mentioned sources of instability, and perhaps not the least important is that it has for its pivot nitrogen, the element which above all others is remarkable for the lability of its compounds. I have elsewhere[1] indicated the probability that the active molecule of living substance consists of an enormous complex of proteids, carbohydrates, &c., linked together by means of the nitrogen atoms, and that the oxygen store is more or less combined with the nitrogen. At the death of the molecule its constituent groups (proteids, &c.) are released, and the store of oxygen passes from the nitrogen into other and more stable forms of combination.

F. J. ALLEN.

Cambridge.

[1] Report Brit. Assoc., 1896, p. 983; and *Proc. Birmingham Nat. Hist. and Philos. Soc.*, 1899.

Chalk Masses in the Cliffs near Cromer.

AT the present time the cliffs near Cromer exhibit some interesting chalk masses in the Glacial drifts. Between East and West Runton Gaps are several of great size and remarkable in position. One, a very long slab-like mass, is bent from being nearly horizontal until it is almost vertical, and thus comes to within a short distance of the top of the cliff. The masses near Trimingham will now repay a close study, for they have changed greatly during the last five years. Both my friend, the Rev. E. Hill, and I have made notes and rough sketches, with the intention of sending to the *Geological Magazine* a short account of what can now be seen; but we earnestly hope that some geologists who are adepts at photography will visit both localities at the earliest possible opportunity, in order to secure a permanent and accurate record of these exceptionally interesting sections.

T. G. BONNEY.

The Rigidity of the Earth's Interior.

THE letter of Dr. T. J. J. See (NATURE, April 13, p. 559) deals with a subject of profound interest to students of the larger problems connected with physical geology. But it appears that, in Dr. See's treatment of the subject, he has overlooked an important point, which I dealt with in a paper read before Section C of the British Association at Birmingham in 1886. Therein I directed attention to the fact that "gravitation" is only a special instance of the law of universal attraction, and as a corollary to this, at any considerable depth within the sphere of the earth, an appreciable factor of what I may call negative gravity must be allowed for, owing to the counter-attraction of the mass of matter situated nearer the surface of the sphere; so that a body placed at the centre of gravity of the earth, whatever its mass or density, would have no weight at all.

I am glad to see that the consideration of "critical temperatures" of *quasi*-solids (the importance of which was emphasised in my little work on metamorphism some fifteen years ago) is receiving serious attention, and I may also point out that the idea of a potentially liquid (or even gaseous) condition of a mass at depths in a practically rigid state is not new; it was treated in a masterly way by Prof. Albert Heim, of Zürich, some twenty years ago, in his magnificent work "Ueber den Mechanismus der Gebirgsbildung." "Ueberlastet" is the word used by Heim to express such conditions, where the pressure is so far "hydrostatic" as to consist of compression acting equally (for the time being) in all directions. Any disturbance in a given portion of the lithosphere of the equilibrium thus existing must result in *shearing movement* if the disturbance be small, and in *flow* in a given direction if the relief in that direction from pressure is great and rapid enough. In the former case we should get "metataxic change," in the latter schistosity; for I still challenge the statement, made recently by a high authority, that "it is only a question of degree between the cleavage of a slate and the foliation of a crystalline schist or gneiss."

Questions relating to tidal action in the rotating lithosphere, and even Lord Kelvin's oft-repeated objection on that ground to the impossibility of any considerable portion of the lithosphere being fluid, because the earth does not undergo the deformation which the physicist would expect owing to the tidal action which should be set up within it, might possibly be seen in a fresh light on taking into account the remarkable facts demonstrated by Prof. John Perry in his lecture on spinning tops, which he gave to an audience of working men on the occasion of the meeting of the British Association at Leeds in 1890. As a "working man" in a real sense of the word, I considered myself privileged to attend that lecture, and was rewarded by finding in my own mind a great difficulty cleared up by Prof. Perry's masterly demonstrations of the practically rigid condition of non-rigid bodies, if only made to rotate with sufficient rapidity, as the equatorial regions of the earth do—something like 1000 miles an hour.

Bishop's Stortford, April 17.

A. IRVING.

Rival Parents.

A CURIOUS example of the rival claims of a pair of thrushes and a pair of blackbirds for the parentage of a young blackbird is being observed in my garden.

A pair of blackbirds built a nest in a small thick laurel, and in another shrub, some 4 feet off, a pair of thrushes also built a nest. The young in both nests were hatched out at the same time, and were successfully reared until they were some eight or nine days old, when a cat attacked the nests (Monday, April 17), killing all the young thrushes and all the blackbirds except one, which was found hidden under the shrubs. It was continually visited after the tragedy by both the old thrushes and old blackbirds, and two or three hours later was removed in some way not observed to a shrubbery twenty or thirty yards away. There for the last five days it has been fed and looked after by both pairs of birds, who mob with exceptional vigour any intruding cat or dog. The young bird seems to have thriven mightily under the attentions of its true and foster parents, who appear in no way to be jealous of one another.

KENNEDY J. P. ORTON.

University College of North Wales, Bangor, April 21.

The Measurement of Mass.

IN the notice of my little book, "Radium Explained," on April 6, twenty-nine lines are devoted to showing that I have reached a wrong conclusion through not knowing that mass is measured by inertia, and I am corrected in these words:—"how is the quantity of matter to be ascertained? The choice practically lies between defining mass by inertia at a given speed or by gravity. . . . As, however, gravity depends on local circumstances, while inertia (at given velocity) does not, the latter property is preferred for the definition of mass, as being more fundamental." So far from rejecting this principle, I state it, in almost the same terms, on p. 84 of my book:—"Mass, or quantity of matter, is usually ascertained by weighing. But weight is merely the force with which the earth attracts, and this varies with our position on its surface. To get an absolute test of mass, which would be independent of position, we may measure the force required to move or stop a body at a certain speed." And nowhere in the book have I supported any argument by the repudiation of the principle here clearly stated. This is a question of fact; the other objection taken is equally ill-founded, but, being on a controversial point, it cannot be dealt with so briefly.

W. HAMPSON.

West Ealing, May 1.

Properties of Rotating Bodies.

PROF. W. H. PICKERING, in NATURE of April 27 (p. 608), refers to the property which a rotating body possesses of assimilating, in certain circumstances, its axis of rotation to a secondary axis of rotation or revolution impressed upon it, and he mentions the fact that this property is rarely described.

It was fully discussed in an elementary lecture given by Prof. Perry at the Royal Institution about fifteen years ago, and afterwards published in the Romance of Science Series under the title "Spinning Tops."

E. W. ROWNTREE.

20 Queen Square, W.C., May 1.

RECENT SPECTROHELIOGRAPH RESULTS.

IN a previous number of this Journal (vol. lxix. p. 609, 1904), under the heading of "A New Epoch in Solar Physics," I gave an account of the magnificent work that Prof. Hale had recently been accomplishing at the Yerkes Observatory with his latest form of spectroheliograph, the instrument being worked in conjunction with the great 42-inch Yerkes refractor, which forms an image of the sun seven inches in diameter.

In the present article it is proposed to give a brief description of another instrument based on the same principle, an account of which was published by M. Janssen, and to indicate some of the results which have been obtained with it. This instrument has been at work at the Solar Physics Observatory during the past year, and in a recent communication to the Royal Astronomical Society I gave a more full account of it, to which reference can be made for more detailed information than is here given.

FIG. 1.—The spectroheliograph, showing the general arrangement of the two slits, the collimating and camera tubes, the moving (upper) and fixed (lower) triangular frameworks.

It is not necessary in this place to refer at any length to the principle which underlies the construction of a spectroheliograph, since this was referred to in the article above mentioned. It will suffice here to say, therefore, that the pictures produced by this new method of solar research give us photographs of the sun in monochromatic light, or in rays of any particular wave-length that is desired. Thus if we require to study the distribution of hydrogen on or around the solar disc we employ a line in the spectrum of hydrogen, if calcium a calcium line, or iron an iron line.

There are, however, several methods of using the spectroheliograph. This instrument may either be employed in conjunction with a large equatorial, in which the solar image is moved across the primary slit by means of the declination motor which moves at the same time and rate the photographic plate; or the primary slit, and with it the whole spectroheliograph, may be moved across the image formed at the focus of the equatorial. The first method is that adopted at the Yerkes Observatory, and the second that at Potsdam.

There is a further method in which a stationary solar image is formed by means of a siderostat and lens, and the spectroheliograph is mounted horizontally and moved in an east and west direction across this fixed image. Such a mode of procedure is that employed at South Kensington.

The advantage of the last mentioned arrangement is that there is no limit to the size or weight of the spectroheliograph; the uniform motion required can be easily and efficiently secured, and lastly, this motion does not in any way affect the steadiness of the solar image under examination.

The South Kensington instrument was erected in the year 1903, but it was not until last year that satisfactory photographs were secured and routine work begun. This success was due to the use of a larger lens (12-inch) for throwing the solar image on the primary slit, the previous lens of 6 inches aperture not giving a sufficiently bright image.

In this curtailed description of the instrument reference of any length need only be made to the spectroheliograph proper. There is nothing particularly novel about the siderostat, except, perhaps, its more than usual size, the large mirror of 18 inches diameter, the two small motors for operating the slow motions in right ascension and declination, and a modified form of Russell control for regulating the speed of the driving clock. This instrument is

placed in a separate house the upper portion of which can be rolled back towards the north. Some distance due south of this, in another building, is the 12-inch Taylor photo-visual lens mounted on a concrete pillar, and still further south, and in the same building, is the spectroheliograph, also mounted on concrete pillars.

Wtih this arrangement the solar beam is thrown by the siderostat mirror continuously due south and in a horizontal direction; this beam then falls on the 12-inch lens, and the solar image in the focus of this lens is thrown on the primary slit plate of the spectroheliograph.

In order to analyse the solar image by allowing each portion of it to fall successively on the primary slit, the latter, and consequently the whole of the spectroheliograph, has to be moved horizontally in an east and west direction, a distance a little more than the diameter of the solar image (in this case 2½ inches). Further, this motion has to be extremely uniform.

The method adopted to accomplish both of these requirements is as follows:—A triangular iron framework (Fig. 1) is supported on three levelling screws on three concrete pillars. A second framework of the same size and material is placed on the first, but separated by steel balls free to roll between small steel plates fixed to each framework near the corners.

The longer side of this isosceles triangle is placed in a north and south direction. The direction of motion of the upper framework is restricted to an east and west line by means of a guide bar fixed to the lower framework; two small levers with rollers attached to the upper framework are pressed against this guide bar by means of small weights, thus ensuring the correct direction.

The actual motion of the upper framework is obtained by weights attached to one end of a steel strap the other end of which, after passing over a pulley mounted on an arm on the lower framework, is fixed to the western corner of the upper framework. This weight always tends to pull the upper framework towards the west, that is towards the right in Fig. 1.

The motion is controlled by a plunger projecting downwards from the upper framework operating a piston in a cylinder full of oil attached to the lower framework. The outlet valve can be so adjusted that any desired rate of motion can be obtained.

Owing to changes of temperature of the oil, different rates of movement can be obtained for any one reading of the micrometer head regulating the outlet valve. It is necessary, therefore, when making an exposure for a "disc" or "limb" picture to take the temperature of the oil into account. This is accomplished by employing a table, made from previous "runs," in which the valve setting can be directly read off from the temperature reading and the required length of exposure.

It is on the upper framework that the optical parts of the spectroheliograph are placed. These consist of a double tube carrying the two slits (Fig. 2) at the northern or siderostat end and the two lenses (4-inch) of equal focal length at the southern end. The dispersion is produced by a single prism of 60°, and a reflector is inserted in the system in order to make the total deviation of the beam 180°. Thus the part of the solar image which passes through the primary slit falls on the collimating lens, is reflected by the 6-inch mirror on to the prism, traverses the latter, and finally, after passing through the camera lens, is brought to a focus in the plane of the secondary slit in the form of a spectrum. By isolating any particular line in this spectrum by means of the secondary slit (Fig. 2) the solar image can be analysed in this wave-length.

For photographing the whole disc of the sun or its immediate surroundings with one exposure the lengths of the slits must be greater than the diameter of the solar image (2½ inches); in the present case they are 3 inches long. Further, owing to the fact that the lines in the spectrum are curved, the secondary slit jaws are curved to the same radius; this necessitates very accurate adjustment of the secondary slit on the line, and means are provided to facilitate such requirements.

In order to obtain a photographic record of the sun in monochromatic light, a fixed photographic plate is held by means of a wooden support as close to the secondary slit as possible (Fig. 2). In this way, as the primary slit moves over the stationary solar image, so the secondary slit traverses with equal speed the stationary photographic plate.

Up till now the secondary slit has usually been

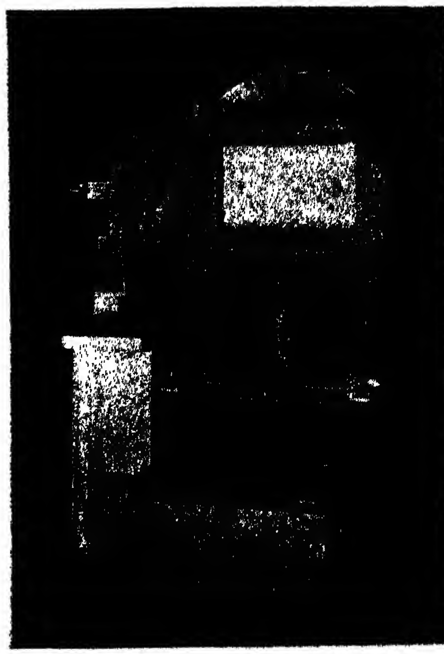


FIG. 2.—The primary slit is on the left and the secondary behind the plate carrier is seen on the right. This illustration shows also the metal disc in position for a "limb" exposure.

adjusted on the "K" line of calcium by eye estimation aided by a small watchmaker's lens, a check being made by taking a photograph of the spectrum, if possible with a sun-spot region, on the primary slit. On bright days this setting can be made with little difficulty, but during the late autumn, with a low sun, the "K" region of the spectrum is not easy to see, and the setting is in consequence very uncertain. A new method just brought into operation entirely eliminates this difficulty, for at a constant distance on the red side of the "K" line a small glass plate has been set with a cross engraved on its surface which can be adjusted on a known line in the more visible region of the spectrum. By bisecting a particular line with the cross the "K" line is adjusted on the slit jaw simultaneously.

The photographs taken during the past year have been of two kinds, the first to investigate the distribution and area of the calcium clouds, or flocculi as Prof. Hale has termed them, on the sun's disc, and

the second the distribution and forms of prominences round the limb. To obtain the latter, a metal disc just a little smaller than the solar image is placed close up to the primary slit plate (Fig. 2), and retained there by a metal wire fixed to a firm base; this disc is so adjusted that it is concentric with the solar image. While in use it becomes extremely hot, and it is therefore necessary that it be made of metal and riveted to the wire which supports it. These limb pictures, an example of which is given in Fig. 3, are of a composite nature in that after the exposure of the limb has been made the metal disc is removed from the primary slit, and a "disc" exposure is made on the same plate. It has been found by experience that a "limb" exposure requires about sixty times the time that is necessary for a "disc" exposure. Under very favourable conditions fifteen seconds is necessary for the latter and fifteen minutes for the former.

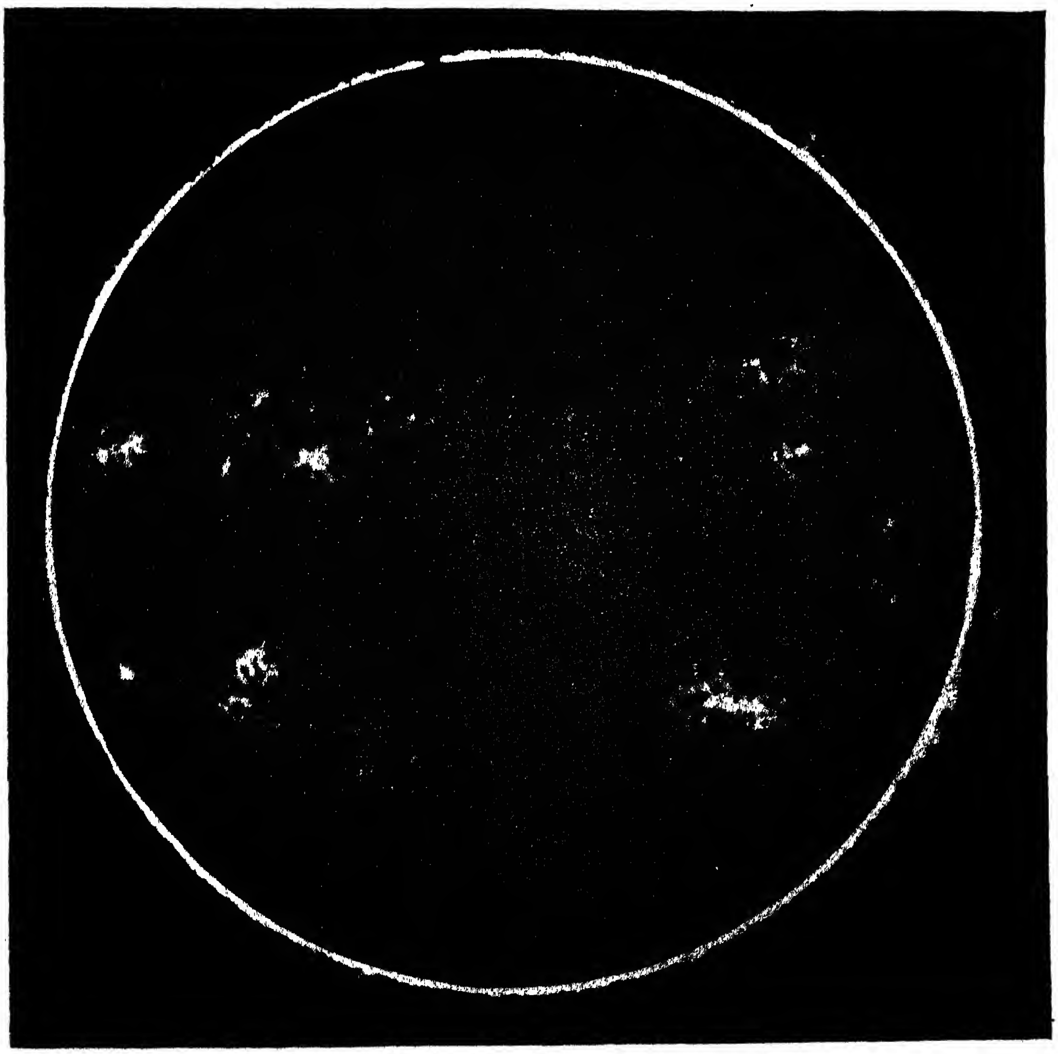


FIG. 3.—Limb and disc of sun in "K" light, July 19. Limb exposed rom 11h. 36m. to 11h. 52m. (interval 16m.); Disc exposed from 11h. 53m. 30s. to 11h. 53m. 48s. (interval 18s.). Enlarged nearly $2\frac{1}{2}$ times.

Without entering into too minute details, the following brief summary of the more salient facts derived from a general survey of the photographs taken during the past year may be given.

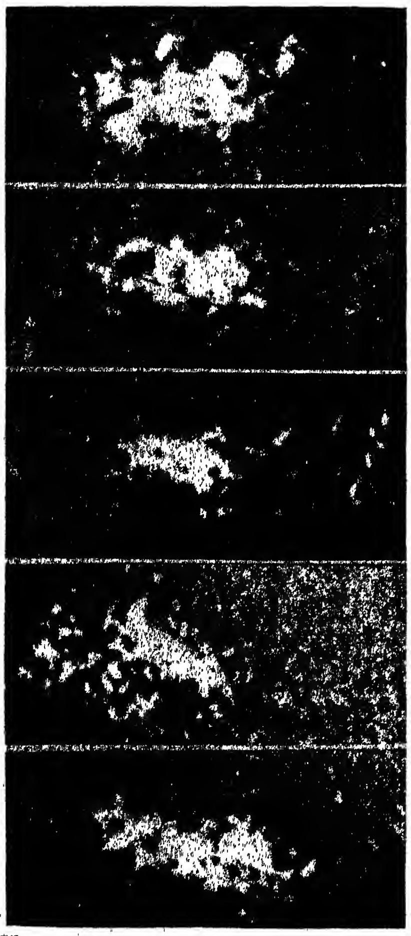
Dealing with the "disc" pictures in the first instance, all of them show a "mottling" of very definite character extending from the equator to the poles. Nearer the equatorial regions this mottling seems to become exaggerated in size in patches, some of the interspaces becoming filled up, giving rise to the prominent flocculi, many of which clearly indicate the mode of structure. Fig. 3 gives an idea of their appearance in the photographs. It will be seen that there are frequently long streaky bright portions springing apparently from a central nucleus and having subsidiary ramifications. A three-legged formation is a very common type of structure in many of the photographs.

These flocculi, in the first instance, exist alone, but

in some of them spots appear at a later stage. No spot has been photographed unaccompanied by a flocculus; in fact, the duration of a spot is only a brief interval in the life-history of a flocculus.

Another interesting subject of inquiry is the position of a spot in relation to the flocculus. Spots more generally make their appearance near the head of, or, in other words, precede the apparently trailing masses of the calcium clouds with respect to the solar rotation, which is from east to west. Some examples of these are given in Fig. 4. When there are two fairly large spots in one flocculus, the larger one nearly always precedes the smaller one.

The composite pictures (Fig. 3) showing the



1904

April 27

April 27

July 14

August 2

August 29

West East

FIG. 4.—Typical cases of spots situated in the front portions of flocculi.

"limb" and "disc" have also brought to light many interesting points which call for further inquiry. In the first place prominences both near the solar poles and equator give strong images in calcium light. Secondly, prominences, which occur nearer the solar poles than the flocculi, do not appear to disturb the regular mottling on the disc in these high latitudes.

Again, an intense flocculus, when on the limb, is not always accompanied by a large prominence. These two last mentioned facts seem to indicate that flocculi and prominences are not always interdependent phenomena.

On continuous fine days, when several photographs of the limb are secured, an opportunity is afforded of studying the changes in the form of large prominences after intervals of a few hours. Two examples of such changes are here illustrated and briefly described.

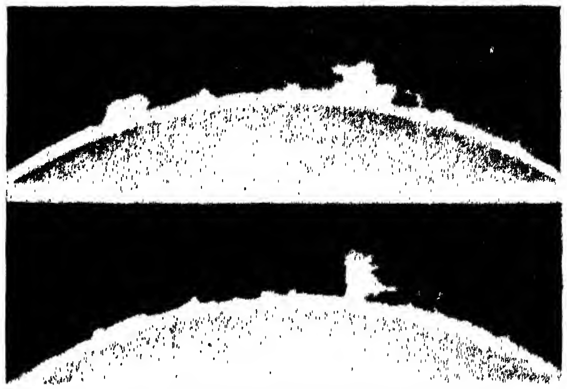


FIG. 5.—Showing changes in prominences after an interval of one hour. (Lower picture taken last.)

In Fig. 5 we have two photographs (only the portions of the limb indicating the particular region of the sun in question are shown) which were taken on July 14, 1904, at 11h. 8m. a.m. and 12h. 8m. p.m. respectively. It will be noticed that during this interval of about one hour a startling change has occurred to the largest prominence; not only has its height been considerably increased, but its form has entirely changed. The material radiating the calcium light seems to have been ejected from the chromosphere and then to have apparently met a strong current moving polewards (that is, from left to right in the figure) which has thrown this material in that particular direction. The change of height from about 50,000 miles to 60,000 miles in this interval corresponds to a velocity of nearly three miles a second.

Not less interesting is the apparent disappearance of the second large prominence in the figure situated on the left.

Another example of a change of form of an enormous prominence photographed on July 19 at 11h. 45m. a.m. and 3h. 59m. p.m. respectively is that shown in Fig. 6. This prominence was situated in the south-east quadrant. The approximate dimensions

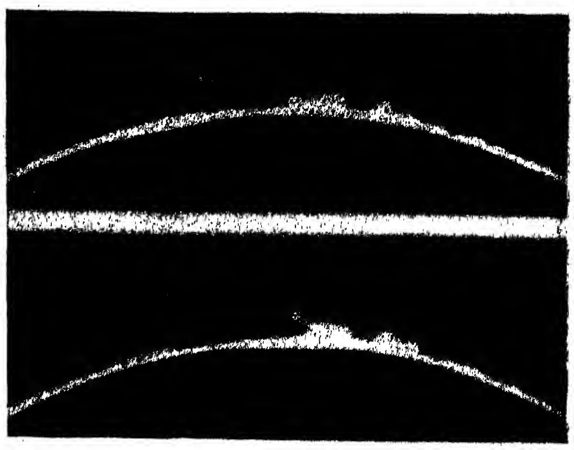


FIG. 6.—Two views of a large prominence taken with a four hours' interval between them. (Lower picture taken last.)

as deduced from measurements of the photographs were as follows :—

Time h. m.		Length in miles		Height in miles
11 45	...	192,000	...	55,000
3 59	...	216,000	...	60,000

When it is mentioned that our earth has a diameter a little less than 8000 miles, an idea of the magnitude of this solar disturbance can be roughly grasped.

An interesting point to notice further in the original is the apparent falling towards the limb of the material forming the highest part of the prominence in the lower picture.

Enough, perhaps, has now been written to give the reader an idea of the instrument at work, and a few deductions from the photographs obtained during the summer months of the past year.

When it is considered that the results described, and others of which no mention has been made, only apply to the photographs secured with the "K" line of calcium, and that other lines in the solar spectrum, such as hydrogen, iron, magnesium, &c., still remain to be examined, some notion of the vast field of work open to investigators becomes apparent.

To avoid too much duplication of work beyond what is absolutely necessary, steps should be taken as soon as possible to subdivide the labour. The past year has seen the formation of a representative body to undertake such a scheme, and it is hoped that more instruments will soon be erected and at work to cope with the large demand of facts relating to our sun rendered now possible by the pioneer work of Prof. Hale and M. Deslandres.

WILLIAM J. S. LOCKYER.

THE TEACHING VALUE OF MENAGERIES.[1]

SO far as the general public is concerned, there is always a very considerable danger lest menageries should be regarded merely as places of amusement and curiosity, and that their great value as teachers of zoology should be more or less completely ignored. The main object of the volume before us appears to be to emphasise the teaching value of institutions of this nature, and to show what admirable schools for acquiring the rudiments of practical zoology lie ready to our hand, if only we will take advantage of our opportunities; in other words, we have nature-teaching of a unique description awaiting our attention. Mr. Beddard treats, indeed, his subject almost exclusively from this point of view, so that his volume forms, in great degree, a sketchy kind of text-book of vertebrate zoology, illustrated by a number of first-class photographs and drawings of the animals under discussion. Such a mode of treatment necessarily prevents the inclusion of any great amount of matter that is really new in his work, and from one point of view it is a matter for regret that the author, with his long experience of the establishment in the Regent's Park, has not seen his way to give us more information with regard to the behaviour and life-history of animals in menageries. One point in this connection on which information is sadly lacking is the duration of life of animals in menageries, and the periods during which individuals of long-lived species have survived in captivity. So far as we have seen, information on this latter point is given only in two cases, namely, in that of the polar bear and that of the pelican. Possibly, however, the author may have in view a companion volume, in which these phases will form the leading theme; and if so, we feel sure that it will supply a marked want.

FIG. 1.—Flamingoes in the Regent's Park. From Beddard's "Natural History in Zoological Gardens."

Restricting, and very wisely so, his volume to the vertebrata, the author commences with a general sketch of the leading features of that group, and then takes in systematic order the various representatives selected for description. Mammals accordingly come first; and it is not out of place to mention that Mr. Beddard directs attention to the fact that a good popular name for this group is still a desideratum. In the case of both mammals and birds, the species taken as examples of different types are in the main well selected, and in nearly every instance the illustrations are almost everything that can be desired. As one of the best, among those reproduced from photographs, we have chosen the group of flamingoes, taken in the gardens, to set before our readers.

[1] "Natural History in Zoological Gardens; being some Account of Vertebrated Animals, with Special Reference to those usually seen in the Zoological Society's Gardens in London and Similar Institutions." By F. E. Beddard. Pp. x+310; illustrated. (London: Archibald Constable and Co., Ltd., 1905.) Price 6s. net.

Typographical errors appear to be comparatively few. The meaning of the last sentence on p. 22 is, however, obscured by the misplacing of the word "much"; while on p. 125 we have *Suiae* for *Suidae*, and on p. 149 Australia for Australian. As regards other matters for criticism, it may be pointed out that the author admits that the term aurochs properly belongs to the extinct wild ox, and it is therefore not easy to see why he applies it to the bison in the plate of that animal. In the section on the wild ass (p. 60), the non-scientific reader will probably find it difficult to ascertain the proper name and the number of races of the Asiatic representative of that group; while the sportsman will gasp with astonishment when told (p. 63) that this animal may be ridden down by an expert horseman after a run of five-and-twenty miles (or does the author mean minutes?). On p. 139 the Tasmanian devil, under the synonym of the ursine dasyure, is made to do duty for two species. Finally, the palæontologist is likely to be staggered by the suggestion (p. 185) that the horn of the American birds commonly known as screamers is a direct inheritance from a dinosaurian ancestor.

Throughout, Mr. Beddard has made his book readable and mildly interesting; and it is especially satisfactory to find that he is conservative as regards the scientific names of the animals he discusses, and is, moreover, sparing in the use of such of these names as he selects to designate the various species. The book should form a valuable companion during a visit to the gardens in the Regent's Park, and likewise an excellent work of reference to those who really desire to learn something from visits of this nature.

R. L.

SCIENCE AT THE ROYAL ACADEMY BANQUET.

AMONG the guests of the Royal Academy of Arts, at the anniversary banquet on Saturday last, were eminent representatives of many branches of science. The president of the Academy, Sir E. J. Poynter, presided; and the Prince of Wales responded to the loyal toast proposed by the chairman. Sir E. Seymour having replied for the Navy and the Duke of Connaught for the Army, the president proposed the toast of "Science," the domain of which, he remarked, appeals to innumerable interests from its utilitarian side, and in its higher aspects deals with matters which, while they transcend the imagination with their speculative possibilities, require for their verification the utmost capacity of the intellect for exactitude and minuteness of research. Sir William Huggins, president of the Royal Society, replied to the toast in the following speech, which we take from the *Times* report of the banquet:—

I rise, as representing the Royal Society, to acknowledge the toast of science, so cordially honoured by her younger sister, the Royal Academy. I say sister, because art and science have in common the same object of worship and study—nature, in her varying moods and aspects; art "to exalt the forms of nature," science "to enlarge her powers." More than this, for to be accepted of nature, to be true artists or true men of science, both must possess an intuitive and profound insight into nature. The fine paintings which surround us are not mere transcripts of nature, but created visions of nature, revealing to the common eye the cryptic poetry and prose visible only to the second sight of the true artist—

"... a painter gazing at a face
Divinely through all hindrance finds the man behind it."

As truly, the man of science must be a seer, endowed with the open eye and power of imagination. At this point the sisters part company. The muse of art fixes on the canvas a momentary aspect of nature, or of the human face divine. The muse of science strains her eyes to see what is behind the outward show, her quest is for the why and wherefore of nature's changes. But science is more than a presiding muse; she is in very deed a great beneficent power imminent in the lives of her votaries, a power such as was feebly foreshadowed in the tales of folk-lore by the Queen of the Good Fairies, richly rewarding by enchantment with all good things those who made her their friend. The seven-league boots and the magic steeds were but poor anticipations of the gifts of science —the railway, the motor, and the turbine-driven vessel. The enchantment of gold, jewels, feasts, and palaces are more than realised by the boundless resources which science places at man's disposal. Science, indeed, brings back the age of Methuselah. Even literally life is prolonged by increased power over disease. True life is not measured by the passing of the suns, but by the sum of our activities; not by the falling sands of the hour-glass, but by the living pulses of the mind. The flying train, the flashing of intelligence, night turned into day, and the thousand and one appliances of machinery crowd into one year a fulness of life which was possible to our fathers only, if at all, in many years. How great, then, would be the gifts of science to the nation in return for full national recognition—by placing science on an equality with the humanities in our universities and public schools, and by the endowment of laboratories worthy of the nation! With science nationally honoured, our armies and our ships could know no defeat, our machinery and our manufactures no rivalry in the world's markets, our every undertaking must prosper. Shall we then remain in deadly apathy and take no steps to have it so?

NOTES.

ON Sunday, the President of the French Republic entertained the King at the Elysée at a dinner party, at which 120 guests were present. The guests included distinguished authors, artists, musicians, and other representatives of intellectual activity, almost exclusively members of the Institute of France. By inviting leaders of literature, art, and science to meet the King, graceful recognition was given of the high place occupied by the muses in the polity of the Republic. In the days when sheer muscular force was the mainstay of a nation, bodily strength and prowess were rightly regarded as recommendations for Court favours; but now that brain-power instead of muscle determines the rate of national progress, the State that desires to advance must foster all the intellectual forces it possesses. This principle is well understood in France, and is also clearly recognised in Germany, where every man who makes notable contributions to knowledge of any kind, assists industrial progress, or creates works of distinguished merit, whatever they may be, is sure to receive personal encouragement from the Emperor. The presence of these leaders of thought is a striking characteristic of the German Court; while, on the other hand, their absence, and the overpowering influence of military interests, are distinguishing features of Russian, and, let us add, of British Court functions.

ON many occasions reference has been made in these columns to the excellent object lesson of the intimate connection between a scientifically organised system of education and national prosperity afforded by the success which has in recent years attended Japanese enterprise. It is gratifying to find that this insistence on our part is, in view of affairs in the Far East, now being echoed by our contemporaries. Commenting upon the account of its Tokio correspondent of the battle of Mukden, the *Times*, in a leader in the issue of April 25, remarked:—"We have before us evidence of national education in its highest and most complete manifestation—education such as we in this country have hardly begun to conceive. We have co-

ordinated intelligence at its best, fortified by an invincible *moral*, and employing a physical education capable of carrying out all its behests. We see these things not merely producing a small *corps d'élite* insignificant in comparison with the mass of the nation, but turning out half a million of men with brain power adequate for their direction." When it is remembered that Japan has established and perfected its system of education in the years since the passing of our first Elementary Education Act in 1870, it is easy to appreciate how profound and speedy can be the effect of an earnest and sustained effort on the part of the Government of a nation to develop its educational resources. There is hope that now our great newspapers are advocating the paramount claims of higher education and science we may see both more generously treated by the Government of this country.

THE inactivity shown by our statesmen in matters concerning the preservation of our ancient monuments compares very unfavourably with the measures taken in other countries to cherish their structures of antiquity. A timely article in the April number of the *Quarterly Review* directs attention to several cases of vandalism to show the precarious tenure on which this country holds so many of its artistic and historical treasures. Here we are almost devoid of the official and semi-official machinery which is actively engaged abroad. France and Austria have State-appointed commissions which exercise a general supervision over historical and artistic monuments, and see to their preservation and proper repair. The French list of structures regarded as of unmistakable national value contains about 2200 monuments, of which 318 are prehistoric in the form of dolmens or cromlechs. The care of monuments in all the German States is in the hands of official custodians or monument commissions, who are responsible to the Ministers of Public Instruction or of the Interior. The minor States of Europe exhibit a similar official interest in historical monuments. In our own country, however, only tentative efforts have been made at arrangements which on the Continent are in full working order. So far as any expenditure is concerned, the Ancient Monuments Acts are almost a dead letter. The indifference of the Government to the whole matter is sufficiently indicated by the fact that since the death of the inspector of ancient monuments, General Pitt-Rivers, in 1900, no successor has been appointed to the post, although no emoluments are attached to it. It seems impossible to get our so-called statesmen to see that unless the State shows active interest in the preservation of our ancient monuments, many of our national assets of the highest historical value are doomed to destruction. The public and public bodies would soon learn to prize such monuments if the Government would take steps to show that these structures are of national importance.

MR. E. T. NEWTON, F.R.S., palæontologist to the Geological Survey, retired on May 4 after a distinguished service extending over forty years. In 1865 he joined the Geological Survey as assistant naturalist under Prof. Huxley, while Murchison was director-general; and when Huxley severed his connection with the Museum of Practical Geology, he worked under the late Robert Etheridge until 1881. On Mr. Etheridge's transfer to the British Museum, Mr. George Sharman and Mr. E. T. Newton were appointed joint palæontologists to the Geological Survey, and on Mr. Sharman's retirement in 1897 Mr. Newton remained as chief of the palæontological department. The loss of his great experience and knowledge on all branches of palæontology, to say nothing of the personal loss, will be widely felt in the museum at Jermyn Street by the officers and by the visitors who come for assistance in the study of fossils. It is satisfactory to learn that Dr. F. L. Kitchin has been appointed to succeed Mr. Newton; he received his palæontological training under Zittel, and joined the staff of the Geological Survey in 1898. He has published important monographs on fossil Invertebrata in the "Palæontologia Indica."

MR. JOHN GAVEY, C.B., engineer-in-chief to the Post Office, has been nominated for election as president for 1905–6 of the Institution of Electrical Engineers.

NEWS has just reached this country that Dr. J. E. Dutton died at Kosongo, in the Congo, on February 27, while actively engaged in the investigation of trypanosomiasis and tick fever.

THE Paris Natural History Museum has accepted a bequest made by M. Emmanuel Drake del Castillo consisting of a herbarium, a botanical library, and a sum of 25,000 francs.

PROF. HANS MEYER, of the University of Vienna, we learn from *Science*, has accepted the invitation to deliver the Herter lectures at Johns Hopkins University on October 5 and 6. His subject will be "The Physiological Results of Pharmacological Research."

IT is announced that the New Mexico legislature has passed a law authorising a geological survey of the State; the sum of 1200*l*. has been voted for the purpose, and is to be expended under the direction of the New Mexico School of Mines at Socorro.

PROF. W. KÖNIG, of Greifswald, has been appointed ordinary professor and director of the physical laboratory at Giessen; Prof. M. Disteli, of Strassburg, professor of mathematics at Dresden; and Dr. Ernest Orloch professor at the National Physical Laboratory at Charlottenburg.

PROF. H. M. HOWE, professor of metallurgy at Columbia University, Bessemer medallist of the Iron and Steel Institute, has been elected foreign correspondent of the Paris Society for the Encouragement of Industry to succeed Sir Lowthian Bell. The other four recipients of this honour are Cannizzaro, Mendeléeff, Solvay, and Sir Henry Roscoe.

MR. J. H. HAMMOND has given 1000*l*. to establish a mining and metallurgical library at San Francisco. The State Mining Bureau already possesses an extensive library, but, for want of funds, it has not been possible to add new books during the past ten years. The new library is to be placed in the rooms of the Mining Bureau, but as a separate unit. Three trustees are to select the books.

THE President of the Board of Agriculture and Fisheries has appointed a departmental committee to inquire, by means of experimental investigation and otherwise, into the pathology and etiology of epizootic abortion, and to consider whether any, and, if so, what, preventive and remedial measures may with advantage be adopted with respect to that disease. The chairman of the committee is Prof. J. MacFadyean, principal of the Royal Veterinary College.

THE Baly medal, given every alternate year on the recommendation of the president and council of the Royal College of Physicians of London for distinguished work in the science of physiology, especially during the two years immediately preceding the award, has been awarded to Prof. Pawloff, of St. Petersburg. The Bisset Hawkins

gold medal for 1905, given triennially for work deserving special recognition as advancing sanitary science or promoting public health, has been awarded to Sir Patrick Manson, K.C.M.G.

A DECIDED earthquake shock was felt in the Vale of Llangollen, North Wales, about 1.40 a.m. on May 1. The disturbance lasted about four seconds, and was accompanied by loud rumbling sounds. The river Dee, which runs through the district, rose several feet during the night.

THE Paris correspondent of the *Times* reports that earthquake shocks were experienced at about 2 a.m. on April 29 over the whole of the Jura, the Rhone valley between Lyons and Valence, and the eastern portion of the *Central Massive*. All the shocks appear to have occurred simultaneously, and were accompanied by sudden and violent squalls, as well as by rumblings like distant thunder. An earthquake shock, lasting eight seconds, was recorded also at Chamonix. Subsequently the shocks recurred, though in a mitigated degree. At this place a new spring suddenly gushed from the ground as the result of the seismic disturbance, and the waters of the river Arve were swollen in consequence. The shock was felt at 2.45 a.m. at Turin and Domodossola. The seismographs at the observatories of Pavia, Padua, Ferrara, Modena, Ischia, and other towns also recorded disturbances. At Heidelberg Observatory the seismograph registered a decided earthquake of short duration at 2.49 a.m.

ATTENTION was recently directed in these notes (vol. lxxi. p. 492) to a statement made in the *Times* that the Tower of Galileo on the hill of Arcetri, near Florence, has been practically destroyed in the course of recent building operations. Prof. A. Ricco, having been led by our note to make a special inquiry at Florence, now writes to point out that the so-called Torre del Gallo cannot in any way be considered as associated with the name of Galileo. Such an association was first suggested comparatively recently and purely gratuitously by the late proprietor of the tower, but no evidence in support of it can be traced either in the numerous letters or writings of Galileo. This was clearly pointed out by Gebler in 1878 in an article in the *Deutsche Rundschau*, and the most recent examination of Galileo's writings made on the occasion of the publication of the "national edition" of his works has given support to the same opinion. It may perhaps be surmised that a confusion of names has occurred, Torre del Gallo, literally the Cock's Tower, being wrongly regarded as a corruption of Torre di Galileo.

IN one of his recent articles on Stonehenge (vol. lxxi. p. 391, February 23) Sir Norman Lockyer referred to the interesting fact, pointed out to him by Colonel Johnston, director of the Ordnance Survey, that the solstitial line in 1680 B.C. passes through not only the present centre of Stonehenge, but also through Sidbury Hill to the north-east, and the earthworks at Grovely Castle and Castle Ditches to the south-west. This continuation of the solstitial line from Stonehenge to other ancient structures is of great interest; but an even more remarkable relation found by Colonel Johnston is that Stonehenge, Old Sarum, and Grovely Castle occupy the points of an equilateral triangle each side of which is exactly six miles in length. A very definite connection is thus shown to exist between the various primitive works in the neighbourhood of Stonehenge. We notice that Mr. J. H. Spencer describes these relationships in an article in the April number of the *Antiquary*, but he does not mention that the credit of the discovery of the connecting lines between the various monuments belongs to Colonel Johnston.

WE learn from the *Journal of the Society of Arts* that funds have been placed at the disposal of the council of the Society of Dyers and Colourists for distribution in the form of prizes for the solution of technical problems. The following prizes are now offered:—(1) 20*l*. for a satisfactory systematic tabulation of the reactions of dyestuffs on the fibre, and a comprehensive scheme for their identification on dyed fabrics; (2) 10*l*. for a trustworthy method of distinguishing between unmercerised and mercerised cotton of various qualities, and for the estimation of the degree of mercerisation without reference to lustre; (3) 20*l*. for a full investigation of the causes of the tendering of cotton dyed with sulphide blacks, and the best means of preventing such tendering; (4) 20*l*. for a satisfactory standardisation of the strength and elasticity of cotton yarns of various qualities and twists in the grey and bleached conditions; (5) 20*l*. for a full investigation of the average degree of tendering brought about in cotton yarn of various qualities by—(*a*) cross dyeing with acid colours; (*b*) dyeing aniline black; and (*c*) various other dyeing processes, with the object of fixing standards for the trade. Further information can be obtained from the hon. secretary, Mr. E. T. Holdsworth, Westholme, Great Horton, Bradford.

SATISFACTORY progress and general prosperity form the key-note of the report of the Zoological Gardens at Gizeh for the past year. The report is illustrated by the reproduction of a most interesting photograph of an aard-vark, or ant-bear, slightly marred by the effect of a shadow by the side of the nose.

IN a communication published in the *Anales of the Buenos Aires Museum* (vol. xii. pp. 1-64), Dr. F. Ameghino gives reasons for concluding that the single facet by which the astragalus of marsupials articulates inferiorly with the calcaneum is a specialised feature, derived from the more common type in which there are two such facets.

THE April issue of the *Proceedings of the Royal Irish Academy* is devoted to a list of Irish Cœlenterata, inclusive of the Ctenophora, by Miss Stephens. The list includes about 250 species, but since the north-west coast of Ireland has not yet been thoroughly worked, it cannot be regarded as complete.

Museum News is the title of a periodical issued by the Brooklyn (N.Y.) Institute of Arts and Sciences to replace the *Children's Museum News*, and intended to deal with matters connected with both the Central and the Children's Museum in that city. Special attention will be devoted to informing the public with regard to new exhibits and additions to the collections.

ACCORDING to its seventy-first report, Bootham School (York) is making a vigorous push in the direction of encouraging the study of natural science, and the natural history club has entered a period of renewed life and vigour. The report is illustrated with reproductions from two excellent photographs, one showing the nest and eggs of a black-headed gull, and the other the same eggs in the process of hatching.

THE seals frequenting Killala Bay and the Moy Estuary in Mayo, form the subject of an article by Mr. R. Warren in the April *Zoologist*. Both the common and the grey seal frequent and breed in this district, the young being apparently born in most cases in caverns difficult of access

The largest grey seal ever killed weighed 560 lb., but specimens scaling 740 lb. and 770 lb. are recorded from the Farne Islands, on the Northumberland coast.

"DIE SOGENNANTEN RIECHSTÄBCHEN DER CLADOCEREN" is the title of a paper in vol. xii. of *Ploner Forschungsberichte*, in which the author, Mr. D. J. Scourfield, of Leytonstone, discusses the function of the so-called olfactory setæ in this group of minute crustaceans. From the stronger and more numerous development of these bristles in the males, it is inferred that their sensory functions are more acute in this sex than in the females. As regards their probable function, the author is of opinion that while they are largely concerned in the perception of taste, yet that they may also serve in the recognition of other senses which may be as far removed from taste as is the latter from hearing.

THE *Journal of Hygiene* for April (v., No. 2) contains a number of interesting and important papers. Dr. Petrie discusses the relationship of the pseudo-diphtheria and diphtheria bacilli, and Dr. Boycott the relative seasonal prevalence of these two organisms. Dr. Petrie also describes trypanosomes observed in rabbits, moles, and certain birds. Dr. Savage, as the result of experiments made to ascertain the degree of sewage pollution of tidal waters, considers that mud samples yield more trustworthy evidence of the degree of contamination than either water or oyster samples. Other papers are by Dr. Hamilton Wright on preventive measures against beri-beri, Drs. Newsholme and Stevenson, and Dr. Hayward on statistical methods applied to birth-rates and life tables, and Dr. Mackie on a handy method of determining the amount of carbonic acid in air.

PART i. of the reports of the commission appointed for the investigation of Mediterranean fever under the supervision of the advisory committee of the Royal Society has just been issued. The first two reports, by Major Horrocks, R.A.M.C., deal with the problem of the saprophytic existence of the causative organism (the *M. melitensis*) outside the human body. It is found that the organism will retain its vitality in sterilised tap water for thirty-seven days, in dry soil for forty-three days, and in moist soil for seventy-two days. The same observer was able to isolate the micrococcus from the urine, but not from the fæces, sweat or breath of patients. A series of experiments was instituted which showed that the micrococcus is absorbed by, and gives rise to the disease in, monkeys exposed to dust, or given food containing it. Staff-Surgeon Gilmour, R.N., and Dr. Zammit detail experiments on the isolation of the *M. melitensis* from the blood, and Staff-Surgeon Shaw, R.N., writes on the same subject and on experimental work in relation to animals.

AN interesting article on polished stone axes in history until the nineteenth century, by Dr. Marcel Baudouin and Lionel Bonnemère, will be found in the *Bulletin de la Société d'Anthropologie de Paris* (5e. sér., tome v., p. 496). Examples are given of their use at the present day as charms against lightning, storm, and other evils, and also they are credited with therapeutic efficacy. The βαίτυλος of the Greeks was a polished stone implement; from classical times onwards these stones were supposed to have fallen from heaven, and at the present day this belief is current from western Europe to Malaysia.

VARIOUS folk-tales and other items of folklore will be found in the *Journal of the Asiatic Society of Bengal*; in vol. lxx., part iii., p. 99, Mr. S. C. Mitra records a new accumulation-droll or cumulative folk-tale from Bihar; in vol. lxxi., part iii., p. 4, in the same *Journal*, Mr. H. P. Shastri describes a form of tree worship at Naihati; a female deity is supposed to reside in a date palm, when clods of earth are thrown at the tree as offerings to her, she at once pacifies children crying at the home of the devotee. Ten years later the author re-visited the spot, and found that sweets were then offered as well, that various other boons were prayed for, and a myth had grown up about the tree. The marriage customs of the Khonds are described by Mr. J. E. F. Pereira, from which it appears that they are gradually Hinduising their customs.

THE ideal forestry college forms the subject of an article in the *Indian Forester* (February); the suggestions made are based upon a selection of the advantages observed at various institutions, all of which, it is hardly necessary to state, lie outside the British Isles. College gardens and forests are mentioned as the most important adjuncts to laboratories and museums, and in these particulars the forestry school at Tharandt, Saxony, is well provided. In the matter of getting wider experience than can be obtained in the college forests, the students of the St. Petersburg Institute have the advantage of inspecting and completing a final course in some of the great forest areas of Russia.

JUDGING from the account by Mr. J. W. White published in vol. xxii., part iv., of the *Transactions and Proceedings of the Botanical Society of Edinburgh*, the Balearic Islands offer many attractions to the botanist who is contemplating a holiday. Not only do the islands lie outside the general track of tourists, but the flora is unusually rich, and a considerable number of the plants are endemic or confined to one of the neighbouring countries. Amongst the rarer curiosities a fragile vetchling, *Vicia bifoliata*, *Lepidium Carrerasii*, and a curious little shrubby *Daphne velloeoides* were obtained in Minorca, and in Majorca *Pimpinella Bicknelli*, which grows in splendid isolation, and a delicate rock-sheltered labiate, *Salvia Vigineuxii*, were discovered.

A RECORD of the progress of the *Albatross* Expedition to the eastern Pacific is given in a letter from Prof. Alexander Agassiz dated January 6 (*Amer. Journ. Science*, April). The influence of the Humboldt current on the marine life west of Callao was investigated. As far as 800 miles from the mainland, it affected both the surface and bottom fauna. Towards Easter Island, the surface fauna first became less abundant, and at a distance of from 1200 to 1400 miles from South America the trawl hauls were absolutely barren. The bottom of the greater part of the line was covered with manganese nodules on which were found attached a few siliceous sponges, an occasional ophiuran, and a few brachiopods and worm-tubes. The pelagic and intermediate fauna from Easter Island to 12° south latitude, in the direction of the Galapagos, was very poor, and indicated that the region was to the westward of the great Humboldt current. Beyond this limit the marine fauna was again rich and abundant, and great changes were noted in the temperature of the water between 50 and 300 fathoms. Soundings made eastward of the Galapagos and Easter Island indicate a gradual deepening of the ocean bed towards the Continent, as observed during the *Challenger* Expedition. On Easter Island some time was spent in examining the prehistoric monuments and the great quarries from which colossal images had been cut. Sculptured rocks were noted, and it was remarked that some of the cyclopean stones used in the ancient buildings exhibited excellent workmanship.

Geological and petrographical researches on the northern Urals have for some years been carried on by Prof. Louis Duparc and Dr. Francis Pearce. Their latest work (*Mém. Soc. de Physique et d'Hist. nat. de Génève,* xxxiv., fasc. v.) embraces a description of the eruptive rocks of the chain of Tilaï-Kanjakowsky-Cérébriansky, in the Government of Perm. This range is composed of basic igneous rocks, of pyroxenites passing into koswites, which form the principal axis of the chain, with bordering gabbros elsewhere prominent; there are diorites, norites which are intercalated locally in both gabbros and pyroxenites, and dunites which are massive in places and also send veins into the gabbros and pyroxenites; and there are other eruptive rocks. All these are described in considerable detail and illustrated. Continuing their observations eastwards, the authors describe the quartzites and crystalline conglomerates of Aslianka and of Tépil, with, in the latter region, Devonian strata and various igneous rocks; and finally they deal with the crystalline schists and intrusive rocks of Koswinsky-Katéchersky-Tilaï. The memoir is illustrated by pictorial views of the topographic features, by longitudinal sections, and by microscopic sections of the rocks.

The report of the observatory department of the National Physical Laboratory for the year 1904 shows, as usual, a large amount of useful work; it is published separately, as appealing to a different class of workers from that interested in the engineering and physics departments. The work of the observatory deals with magnetic, meteorological, and seismological observations (separately), experiments and researches, verification of instruments and watches (separately), and miscellaneous commissions for inland, colonial, and foreign institutions, &c. It is observed that the electric trams have interfered with part of the magnetic work; the mean declination for the year was 16° 37′·9 W. The tabulations and automatic records of the meteorological observations are sent to the Meteorological Office for publication in detail; the Kew report contains monthly and yearly summaries of the results. The seismological observations are published in the report of the British Association; the largest disturbance recorded during the year took place on April 4, when the maximum amplitude exceeded 17 mm. The verification of instruments, exclusive of watches and chronometers, amounted to 25,797, of which 15,903 were clinical thermometers.

During a thunderstorm it has often been noticed that some flashes of lightning appear to "flicker," while others seem to leave a glow in their paths which lasts a second or two before entirely disappearing. In the first case the apparent trembling of the light is due to the fact that the observer is actually watching the passage of more than one flash following the same route. In multiple or intermittent lightning flashes there are sometimes as many as five or six separate flashes in a very brief interval of time, and the impression on the retina is an apparent flickering of a single flash. In the *Comptes rendus* (April 10) M. Em. Touchet directs attention to those particular flashes which leave a glow in their wake, and gives an illustration of a photograph of one he secured with a moving camera on April 12 of last year. The object of the communication is to point out that this glow is attributable to the incandescence of the air; but it seems to us that this is a fact already very well known. In photographing very bright lightning flashes with movable cameras it is a very common occurrence to get trails on the plate of the brighter portions of the flash, and if the plate and lens be very rapid it should be the rule rather than the exception. There are numerous examples of flashes which have been photographed showing this peculiarity, and it is a simple matter to differentiate between those due to multiplicity and those due to the incandescent air resulting from the original flash. Anyone interested in this question will find some typical photographs published by L. Weber (*Sitz. d. k. Preuss. Akad. d. Wiss.*, vol. xxxviii., 1889), Ladislaus von Szalay (*Met. Zeit.*, vol. xxxviii., 1903, p. 341), and B. Walter (*Jahrbuch d. Hamburgischen Wiss. Anstalten*, vol. xx., 1903). As M. Touchet refers to Dr. Hoffert's paper on intermittent lightning-flashes (*Phil. Mag.*, August, 1889), reference is there made to "streaks of light, showing that a very considerable residual illumination remains between the discharges," which indicates that the writer was quite familiar with the incandescence of the air due to the flash and its effect on the photographic film.

An installation for the production of high-tension electricity, on view at Messrs. Isenthal and Co.'s, 85 Mortimer Street, Cavendish Square, W., has been examined by a representative of Nature. The original source of the energy is an ordinary uni-directional current, and an important feature of the apparatus is a commutator which does away with the necessity for an interrupter. In the main circuit is a condenser of very large capacity, and the commutator breaks the circuit when the condenser is charged, so that no sparking is produced. The condenser employed is not large, and owes its compactness to the use of thin layers of aluminium oxide, prepared electrolytically, as the dielectric. The commutator has the appearance of a piece of engineering work, and should not require much attention. Oscillatory currents, with a frequency of about a thousand per second, are set up in the primary of an induction coil, and it is claimed that the impulses in the secondary are much stronger in one direction than in the other. The apparatus is also intended for the production of alternating currents, and some very interesting experiments are shown. An alternating current is sent through the coil of an electromagnet, the core being vertical; a sheet of paper is placed over the upper pole, and on the paper is scattered some iron dust (not filings); the dust forms itself into little spiked heaps which move and dance about. When the paper and iron dust are removed, and the forehead is placed near the pole of the magnet, the light of the room appears to fluctuate in intensity.

Messrs. A. Brown and Sons, Ltd., will publish during this month a work by Mr. J. R. Mortimer entitled "Forty Years' Researches in British and Saxon Burial Mounds of East Yorkshire, including Romano-British Discoveries and a Description of the Ancient Entrenchments on a Section of the Yorkshire Wolds."

The report of the council of the Hampstead Scientific Society and the proceedings for 1904 have been received. Fifty-six new members were elected during the year, and the number of members is now 333. The number of meetings held in 1904 was thirty-three, and in addition there were four Christmas lectures to children and a course of six lectures on nature-study. Among lectures delivered at general meetings of the society may be mentioned one by Prof. S. P. Thompson, F.R.S., on Japanese magic mirrors, and one by Prof. W. Boyd Dawkins, F.R.S., on the incoming of the Brythons into Britain.

Messrs. S. Rentell and Co., Ltd., have published a fifth edition of "The Telegraphists' Guide to the Departmental and City and Guilds Examinations in Telegraphy," by Messrs. James Bell and S. Wilson. The contents have

been revised thoroughly, the chapters re-arranged, and much fresh matter introduced. The extra pages supply a description of Wheatstone's ABC instrument, a more detailed reference to batteries, single-needle working, duplex and Wheatstone automatic systems, repeaters, test cases, concentrator switch, wireless telegraphy, and other subjects.

No. 5 of the *Central*—the magazine of the Central Technical College—is very good, and may be regarded as even constituting an advance on its predecessors. It contains an account by Mr. R. Freeman of the design and construction of the steel-work of the bridge over the Zambezi at Victoria Falls, a continuation of the series of articles by Prof. Armstrong on the mechanism of combustion, and a description of the Klingenberg carriage switchgear by Mr. J. D. Griffin. The magazine is well and copiously illustrated.

WE have received from Mr. Geoffrey Martin a copy of a paper on the theory of solution, published in the *Journal of Physical Chemistry* (vol. ix. p. 149), giving a detailed account of views already briefly stated in a letter to NATURE (vol. lxx. p. 531). An attempt is made to explain the fundamental facts that for all substances there is a limit of solubility in each solvent, that the solubility increases as a rule with the temperature, and that molecules often dissociate on passing into solution.

AMONG the popular science lectures to be delivered at the Royal Victoria Hall, Waterloo Bridge Road, during May are the following:—May 9, fishes old and new, Dr. Smith Woodward, F.R.S.; May 23, some summits of the lost continent Atlantis, Mr. H. Ling

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A TENTH SATELLITE TO SATURN.—A telegram from the Kiel Centralstelle announces the discovery of a tenth satellite to Saturn by Prof. W. H. Pickering, who, it will be remembered, also discovered Phœbe, the ninth satellite.

The newly discovered satellite is very faint, being reported as three magnitudes fainter than Hyperion, the seventh satellite, which has a magnitude of about 17; its period is given as 21 days, and its orbital motion is direct.

THE ALLEGED IDENTITY OF COMETS "BROOKS 1889" AND LEXELL.—An abstract of a paper by Dr. Charles L. Poor, wherein he discusses the identity of Brooks's 1889 comet with the object known as Lexell's comet, is given in No. 4, vol. xiii., of *Popular Astronomy*. After mentioning the discovery and subsequent history of each body, he discusses the various perturbations to which each has been subjected, and then gives the results obtained from a re-computation of the orbit of Brooks's comet, using the observational data secured during the re-appearance of 1903. Finally, he arrives at the conclusion that the objects are not identical, although further evidence will be necessary before the question can be settled definitely.

ANCIENT DRAWINGS OF CELESTIAL PHENOMENA.—Parts xiii. and xiv. of the current volume of *Das Weltall* contain an interesting article by Dr. W. Lehmann, of Berlin, in which the ancient Mexican accounts of solar eclipses, comets, &c., are discussed. The article is freely illustrated by drawings of eclipses, comets, the moon, planets, &c., taken from the old accounts, and these drawings are most interesting as depicting the old Mexican ideas of these phenomena. For instance, the first is a contemporary drawing of the total solar eclipse of 1531 A.D., and shows plainly immense prominences and coronal wings.

MOUNT WILSON OBSERVATORY.—In No. 2, vol. xxi., of the *Astrophysical Journal*, Prof. Hale gives an account of the conditions of solar research at Mount Wilson, California, where he has recently established the Solar Observatory of the Carnegie Institution of Washington. In the first of the two articles he enumerates the requirements of the site of such an observatory, and then discusses in detail the meteorological conditions, the seeing, the transparency of the atmosphere, and the instruments available at Mount Wilson.

In the second article the author describes the foundation, the equipment, and the programme of the observatory, and illustrates his description with photographs and diagrams of the site and of the various instruments and houses already erected or in course of erection.

ANOMALOUS DISPERSION AND "FLOCCULI."—In No. 3, vol. xxi., of the *Astrophysical Journal*, Prof. Julius advances the theory of anomalous dispersion to explain the varying appearances of the flocculi on spectroheliograph photographs. The "dark flocculi" of Prof. Hale are explained by the incurvation of the direct rays producing an excess of light in the bright flocculi, and therefore a deficit elsewhere, hence the dark regions naturally ensue.

The differences between the H_2 (calcium) and $H\beta$ (hydrogen) pictures obtained by Prof. Hale are explained by the supposition that the $H\beta$ rays are less strongly incurvated, and therefore rays of more varied refractive indices pass through the secondary slit, thereby producing a less dark and less defined image. On this assumption Prof. Julius states that the hydrogen photographs would show the fine details seen on the K_1 photographs if the dispersion employed were greater, or if the secondary slit were used narrower. Without requiring any other hypothesis, Prof. Julius explains by this theory all the anomalies seen on the spectroheliograms.

In the same journal, the same author also discusses the "dispersion bands" seen in the spectra of δ Orionis and Nova Persei, and, *inter alia*, arrives at the conclusion that the former star is *not* a spectroscopic binary.

ASTRONOMICAL SOCIETY OF AMERICA.—Abstracts of sixteen of the numerous papers read at the sixth meeting of the Astronomical and Astrophysical Society of America, held at Philadelphia last December, are given in No. 533 of *Science* by Mr. Frank B. Littel. The various titles are too numerous to mention here, but amongst them we may notice "The Constant of Aberration," by Prof. C. L. Doolittle, in which the author obtains the value $20''.540 \pm 0.0055$ from a series of zenith telescope observations made between December, 1889, and December, 1903; "The Reflex Zenith Tube," by the same author; "Variation of the Bright Hydrogen Lines in Stellar Spectra," by Miss Annie J. Cannon; "Planetary Spectrograms" and "The Canals of Mars," by Mr. Lowell; "The Coordination of Visual and Photographic Magnitudes," by Mr. J. A. Parkhurst; and "Recent Researches of the Henry Draper Memorial," by Prof. E. C. Pickering.

COLOUR IN WASPS OF THE GENUS POLISTES.

IN the paper referred to below[1] the author deals very fully with the various colour variations observable in the species of the genus under notice, and a very interesting account is given of the variability in colour-pattern, and of its gradual development in the nymphal and imaginal stages, illustrated by coloured plates i. and ii. A chemical analysis of the nature of the pigments is also given, and illustrations of the layers in which the pigments are located. Coloured plates iii. and iv. give figures of several of the different species of the genus—besides these plates there are excellent maps, showing the distribution of the various forms, and elaborate diagrams are provided, indicating the variations observable. The author has evidently spared no pains to render the treatment of the subject as exhaustive as possible, and as a study of colour variation this treatise seems to leave little to be desired. The problem attacked in this work, viz. "an inquiry into the nature and probable causes of specific differentiation in the genus Polistes," is one which is both difficult and perplexing.

The author commences at once by saying, "apart from differences in size, the characters used to separate the species are based almost exclusively on colour; accordingly, this in-

1 "Coloration in Polistes." By Wilhelmine M. Enteman. Pp. 88 6 plates. (Carnegie Institution of Washington, November, 1904.

vestigation resolves itself into a study of coloration in the genus." The conditions which make for variation in the different species are well indicated, as the author points out that, even where the inmates of a single nest are examined, the following points have to be considered:—First, that two or three females may work together for the good of one community, and may be very differently coloured; secondly, that each may be fertilised by several males, which again may be differently coloured; thirdly, that intruders from other nests may be present as they "are not always so certainly driven away from strange nests as has been affirmed for other social Hymenoptera."

In these circumstances, the attempt to distinguish the species by colour characters seems to be almost hopeless—a point, however, which seems to the present writer to have been overlooked is the possibility of the presence of unobserved plastic characters which might serve as better and more satisfactory guides to classification. That such characters exist among the palæarctic species has been demonstrated by F. F. Kohl in *Ann. K.K. Naturh. Hofmuseum*, Wien, xiii., heft i., pp. 87–90, taf. iii., who shows that five forms of the males can be easily separated by well-defined characters in the form of the clypeus and genæ, the grooves of the face, and the shapes of the subapical joints of the antennæ, and although their respective females and workers have not been satisfactorily identified, it is not improbable that careful investigation may yet disclose characters to associate the sexes of the different species together; as also it is quite probable that all the species would vary in colour in more or less parallel directions—any investigation into the distribution of the species, unless conducted with special reference to these characters of the males, would be very liable to lead to wrong conclusions. One conclusion especially to which one would like to apply the male character test is summed up in the following words:—"It is hardly probable that we have in *P. variatus* a primitive species which has differentiated in two directions, but, as we shall see from the study of the geographical distribution of the species, aurifer and pallipes are two originally distinct species which, from the course of their migration northwards, have come together in the Mississippi valley, and by their commingling produced a species having, in some measure, the characters of both." These remarks are made with no wish to depreciate, even if it were possible, this very careful attempt to investigate a most difficult problem, but merely to point out that there are characters in our Palæarctic species of Polistes which might be well looked for in those of the other hemisphere.

THE CLEAVAGE OF SLATES.

THE memoir described below[1] contains an account of experiments undertaken to test the author's theory, propounded some years ago, of the cause of the cleavage property in slates. Dr. Becker's theory, substantially the same as that put forward earlier by the Rev. O. Fisher, is that cleavage-planes are planes of maximum tangential strain, or in other words shear-planes. This is opposed to the theory of Sharpe (or, as we might say, of Sharpe and Sorby), which makes the cleavage-planes perpendicular to the maximum compression. The author has misunderstood Dr. Sorby's position, having apparently overlooked the earlier papers of that writer. The question whether heterogeneity in the rock is necessary for the production of cleavage seems to be beside the mark, since all rocks (other than glasses) are heterogeneous in this sense. Both Tyndall's wax and Dr. Becker's ceresin, being crystalline bodies, are heterogeneous, and their behaviour must depend on the orientation of the minute component crystals.

The experiments described were carried out with ceresin, a substance of the paraffin series, and some also with clay. These were submitted in one series of tests to simple compression, and in another series to shearing by means of a machine devised for the purpose. In the small masses dealt with the strains developed vary greatly from point to point, and the resulting structure is of a complex kind. We must confess that we are not convinced that the effects observed are such as to be rightly described as cleavage—they have rather the character of fractures, depending on the application of the forces which produce them, as well as on the intimate structure of the material.

It is unfortunate that no attempt is made to collate the results of the experiments with actual examples of cleaved rocks. As the author remarks, the position of the strain-ellipsoid affords a crucial test. On the Sharpe-Sorby theory the principal diametral plane of the ellipsoid must coincide with the cleavage-plane; on Dr. Becker's hypothesis it should be inclined at some angle of less than 45°. Now there are many slates in which the strain-ellipsoid is actually presented in deformed spherical concretions or colour-spots. The "birdseye" slate of Westmorland and the green-spotted purple slates of Llanberis are examples familiar to every English geologist. In every case the orientation of the ellipsoid is that which agrees with the received theory. Moreover, the spots are elliptic in the cleavage-plane itself, being elongated, as Dr. Sorby pointed out fifty years ago, in the line of cleavage-dip. If the cleavage-plane were a plane of shearing, it would correspond with a circular section of the ellipsoid.

We might object further that, since there are two directions of circular section, or of shearing, there should, on Dr. Becker's hypothesis, be always two directions of cleavage, perpendicular to one another with incipient cleavage and making an acute angle in well cleaved slates. Our author endeavours to meet this difficulty in discussing his shearing experiments. One direction of shearing is parallel to a fixed face of the block undergoing deformation, while the other is continually changing, "so that any one set of particles undergoes maximum tangential strain along these planes only for an infinitesimal time." Even assuming such conditions to be realised in nature, which cannot be the general case, we should still suppose that the cleavage-property (as distinguished from fractures set up in the process of deformation) will depend on the actual structure of the rock, not on the manner in which that structure has been arrived at.

It will be apparent from the foregoing criticism that, while recognising the intrinsic value of these experiments and the clear manner in which the author's views are set forth, we do not find in them anything which assails successfully the generally accepted interpretation of the cleavage structure.

A. H.

1 "Experiments on Schistosity and Slaty Cleavage." By George F. Becker. Pp. 34; 7 plates. *Bull.* No. 241 of U.S. Geological Survey. Washington, 1904.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—By direction of the Board of Geographical Studies, part ii. of the examination for the diploma in geography will be held on June 21 and two following days. No person is qualified for admission to part ii. who has not previously passed part i. (or the special examination in geography for the ordinary B.A. degree). The names of intending candidates, together with the subjects they propose to take up, should be notified to the registrary not later than May 24. The fee for admission to the examination is, for members of the university, 3*l.*; for persons not members of the university, 5*l.* The fee must be paid to the registrary not later than June 15. The subjects are regional geography, surveying and mapping, geomorphology, oceanography and climatology, the history of geography and anthropogeography. Copies of the schedules defining the range of examination may be obtained by application at the registry.

The council of the Senate has recommended that the University of Queen's College, Kingston, Ontario, be adopted as an institution affiliated to Cambridge University.

It is understood that the syndicate for considering the studies and examinations of the university, the report of which in favour of the abolition of compulsory Greek in the previous examination was thrown out last term, will continue to meet. It is proposed to add to the syndicate Mr. E. S. Roberts, master of Gonville and Caius College, Dr. Adam, one of the tutors of Emmanuel College; Mr. S. H. Butcher, late professor of Greek at Edinburgh University; and Mr. G. H. Hardy, of Trinity College. These gentlemen were on the "non-placet" side at the

last vote, but it is understood that the majority of them are in favour of some alteration in the present state of things.

A VERBATIM report of the proceedings of the Welsh national conference on the training of teachers and pupil teachers, held at Shrewsbury last November, has just been published. An account of the conference appeared in NATURE of November 17 (p. 66).

THE council of the City and Guilds of London Institute has conferred the fellowship of the institute on Mr. H. Cecil Booth in recognition of the engineering work done by him since he gained his diploma of Associate of the City and Guilds Institute in 1892.

ON Wednesday, June 7, Viscount Goschen, as Chancellor of Oxford University, will lay the foundation-stone of the new buildings of Reading University College, to be erected, at a cost of about 80,000*l.*, upon a site presented by Mr. Alfred Palmer.

AT the recent installation of Dr. Edwin A. Alderman as president of the University of Virginia, it was announced, says *Science*, that in addition to the conditional gift of 100,000*l.* from Mr. Carnegie, Mr. Rockefeller had given 20,000*l.*, Mr. Jefferson Coolidge 10,000*l.*, and alumni and friends 10,000*l.* towards the endowment fund.

MR. CARNEGIE has added another handsome donation to his many princely gifts to higher education. This time he has given 2,000,000*l.* to provide annuities for college professors prevented by old age or other physical disability from continuing to earn salaries. The gift is to be for the benefit of the United States, Canada, and Newfoundland, and applies to all universities, colleges, and technical schools without regard to race, colour, or creed, but excluding State or colonial institutes, and excluding also purely sectarian institutions. The fund is to be vested in trustees, among them Presidents Hadley, of Yale University; Eliot, of Harvard University; Harper, of the University of Chicago; Butler, of Columbia University; Schurman, of Cornell University; and Wilson, of Princeton University, all of whom have accepted. Mr. Carnegie hopes that by this endowment the best men available will be attracted to professorial work, since in view of the retiring pension, which will now be secured, present day salaries will not appear very inadequate in comparison with those of other professional men.

ON his way to Simla for the summer months, Lord Curzon visited Pusa and laid the foundation-stone of the agricultural college there. The Pusa estate comprises some 1280 acres of soil on which almost any crop may be grown. The Government proposes to concentrate there all the agricultural skill, scientific, practical, and educational, to be procured. The buildings will cost 16½ lakhs of rupees, of which amount the laboratory and its fittings will absorb 7½ lakhs. Pusa will provide for agricultural students research in the laboratory, experiment in the field, and instruction in the class-room. After laying the stone Lord Curzon, we learn from the *Times*, referred to the circumstances in which he received from Mr. Henry Phipps, the American millionaire, the munificent bequest which was the origin of the institute. The college, Lord Curzon continued, will form a centre of the application of science to Indian agriculture, and it is hoped that each province of India will in time possess its own staff, its own institute for research and experiment, in fact, a properly organised agricultural department. The Government has no desire to monopolise the field, and will lend every possible advice to great land holders conducting their own experiments, improving their own seed and the breed of their own cattle. Earlier in the day Lord Curzon, replying to an address of welcome from the Behar planters, said that the problem confronting the indigo growers since the synthetic indigo of Germany was perfected some eight years ago is so to combine scientific methods with cheapening of the cost of production as to enable them to produce a natural colour at a price permitting of competition with the artificial product.

WE have received from the Agent-General for New South Wales a copy of a "Statistical Account of Australia and New Zealand, 1903–4," by Mr. T. A. Coghlan. An important section of the volume deals with education, and a prominent place is given in this summary to university and technical education. It appears that the Government endowments to the universities of Sydney, Melbourne, Adelaide, and Tasmania in 1903 were respectively 15,533*l.*, 13,500*l.*, 6611*l.*, and 4000*l.* In addition to the annual endowment, the Adelaide University has received a perpetual endowment of 50,000 acres of land from the Government of South Australia. The University of New Zealand—which is an examining, and not a teaching, body—has a statutory grant of 3000*l.* a year from Government, and of the affiliated colleges Auckland University College is in receipt of a statutory grant of 4000*l.* a year. The University of Otago derives a sum of about 5500*l.* annually from rents of reserves. The Australasian universities are empowered to grant the same degrees as the British universities, with the exception of degrees in theology. Women are admitted to all the universities. As regards technical education, the State expenditure upon it in five of the Commonwealth provinces and New Zealand is as follows:—New South Wales, 26,500*l.*; Victoria, 16,400*l.*; Queensland, 7200*l.*; Western Australia, 5710*l.*; Tasmania, 2500*l.*; and New Zealand, 21,000*l.* In addition to ordinary technical classes throughout New Zealand, there are schools of mines in the chief mining districts, and the Government makes an annual grant of 500*l.* towards the endowment of the chair of mining and metallurgy at the Otago University. Facts such as these show that administrators in Australia and New Zealand are alive to the part which higher education should take in the life of the State, and are willing to supply funds from the public treasury to assist the work of their colleges and universities.

A LETTER from Prof. W. Ridgeway in the *Times* of April 27 contains a number of wise suggestions for the improvement of the education given to boys in secondary schools. Referring to the recent vote on the Greek question, he says, careful inquiries give reason to believe that many voted to make Greek optional simply because they believe that the system of education at present in vogue in public schools is bad, that too much time is given up to Latin and Greek, that, as a rule, science is not taught at all, that the universities are in a large measure responsible for the existing state of things, and that something must be done to improve matters; and accordingly, as somebody must be thrown overboard, Greek was the proper Jonah. Prof. Ridgeway goes on to argue that the mere abolition of compulsory Greek would not have effected any improvement in the method of teaching the older subjects in the schools or have done anything to make the teaching of science general. Moreover, he rightly remarks, there can be no reform worthy of the name which does not ensure that boys whose tastes are literary should learn the methods of science, whilst boys whose bent is to science should get a literary training to give them the power of expressing their ideas with lucidity and to imbue them with a taste for culture. The faulty teaching of the schools, he continues, is due in the main to the specialisation which is required by the open scholarship system, and to the sacrifice of the average boys to those who show greater promise and are likely to win scholarships. The universities are largely responsible for this state of things, for they deliberately encourage premature specialisation in boys of promise by their system of open scholarships, and permit the interests of the average boys to be sacrificed by allowing boys to matriculate before they have passed any examination to show that they have acquired a sufficient modicum of liberal education to serve as a basis for a university training.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 16.—"A Determination of the Amounts of Neon and Helium in Atmospheric Air." By Sir William **Ramsay**, K.C.B., F.R.S.

The author had already attempted to estimate the amounts of krypton and xenon in air by the evaporation of relatively large quantities of liquid air. No doubt much krypton and some xenon evaporated, hence the figures given were necessarily minimum estimates. Dr. Travers

and the author made a rough guess at the proportions of neon and helium in air; the amount of each gas obtained was known, but the quantity from which they were derived could only be guessed at. The figures were:—of helium one or two parts per million, and of neon one or two parts per 100,000.

The ingenious method devised by Sir James Dewar of cooling a dense form of charcoal with liquid air, and using it as an absorbent for gases, made it easy to obtain a nearly correct estimate of the amounts of the more volatile constituents. After oxygen, nitrogen, and argon had been absorbed from about 16,800 c.c. of air by exposure to 100 grams of charcoal cooled with liquid air, the neon and helium were removed with the pump. They were freed from traces of heavier gases by a similar method, and a partial, but fairly complete, separation of the two was effected in the same way. The total quantities were measured by a form of burette, in which the level of the mercury was set to a point, and the differences of pressure read.

The results are:—

	In air 1 vol. in	In crude argon 1 vol. in	Percentage By weight	Percentage By volume
Neon ...	80,790 ...	757 ...	0·000086 ...	0·0000123
Helium..	245,300 ...	2300 ...	0·00000056 ...	0·0000040
Together	61,000 ...	571 ...	— ...	—

It was not possible to detect the free hydrogen in this quantity of air; after the crude mixture of neon and helium had been mixed with a trace of oxygen and sparked for a few minutes, no contraction was observed; the volume of the gases was the same before and after sparking.

April 6.—"On Reciprocal Innervation of Antagonistic Muscles.—Seventh Note." By Prof. C. S. **Sherrington,** F.R.S.

If the crossed extension reflex of the limb be examined before and after a prolonged flexion reflex an alteration is evident in it. When a carefully adjusted electrical stimulus is at regular intervals applied to the afferent path of one limb and the resultant extensor reflex of the crossed limb is noted, it is found that if in one of the intervals a flexion reflex of the latter limb is induced and maintained for twenty seconds or more, the extensor reflex becomes altered in consequence. For a period immediately following the flexion reflex the extension reflex is increased. The intensity of the reflex is heightened, its duration is prolonged, and its latent time is reduced. If the testing stimulus be subliminal the threshold value of the stimulus required by the reflex is found to be lowered. In short, the activity of the flexion arcs directly or indirectly induces in the extension arcs a super-excitability as tested by crossed extension just as when tested by the extensor thrust.

But although this after-effect of the activity of the flexion arcs upon the antagonistic arcs, both direct and crossed, is one of increase of activity, the primary effect is, as shown previously, one of depression. In these instances there supervenes on the spinal inhibition a rebound effect of augmentation.[1]

The "spinal induction" is obviously qualified to play a part in linking reflexes together in a coordinate sequence of successive combination. If a reflex arc A during its own activity not only temporarily checks the discharge-action of an opposed reflex arc B, but also as a subsequent result induces in arc B a phase of greater excitability and capacity for discharge, it predisposes the spinal organ for a second reflex opposite in character to its own in immediate succession to itself.

Much of the reflex action of the limb that can be studied in the "spinal" dog bears the character of adaptation to locomotion. "Spinal induction" obviously tends to connect this "extensor thrust" as an after-effect with precurrent flexion of the limb. In the stepping forward of the limb the flexion that raises the foot and carries it forward clear of the ground, though temporarily checking the reflex discharge of the antagonistic arcs of extension, is, as it continues, so to say, sensitising them to respond later in their turn by the supporting and propulsive extension of the limb necessary to progression. In reflex sequences an antecedent reflex would thus not only be the means of bringing about an ensuing stimulus for the next reflex,[1] but in such instances as the above will predispose the arc of the next reflex to react to the stimulus that will arrive.

1 Sherrington, Schäfer's "Text-book of Physiology," vol. ii., p. 841, 1900.

"Further Experiments and Histological Investigations on Intumescences, with some Observations on Nuclear Division in Pathological Tissues." By Miss Elizabeth **Dale.** Communicated by Prof. H. Marshall Ward, F.R.S.

(1) This paper is the third of a series on intumescences, and deals chiefly with two plants, *Solanum tuberosum* and *Populus tremula.* On the potato plant intumescences were obtained experimentally in about twenty-four hours, either on the uninjured plants or on small fragments of leaves. The effect of nutritive solutions on the formation of intumescences was investigated.

(2) Additional anatomical observations were made, and a classification of various types of intumescences has been drawn up. The cell contents were examined and compared.

(3) The occurrence of acids and salts was investigated.

(4) The experiments show that the internal causes of intumescences are *extremely local,* and quite independent of root pressure. The osmotically active substance is probably *oxalic acid.*

The present experiments show the importance of *irritability* and *active powers of assimilation,* as well as of *moist air, heat, light,* and, generally, oxygen.

(5) Finally, the nuclear phenomena were investigated and compared, and were found to be in every respect identical in various intumescences and in wound-callus. Pathological tissues in certain plants and animals are also compared, and a strong resemblance is seen to exist between certain *rapidly* formed outgrowths in plants and animals, caused not by any parasitic organism, but simply by the influence of some stimulus, probably always external, acting upon a plant or animal in such a condition of irritability that it is able to respond. A similar resemblance occurs between regenerative wound tissues in certain plants and animals, the formation of which is in all cases accompanied exclusively by the more rapid form of nuclear division known as amitotic or direct.

Zoological Society, April 18.—Mr. H. Druce, vice-president, in the chair.—The horn-core (with sheath attached) of an Urus (*Bos primigenius*): J. G. **Millais.** The specimen was believed to be the only British example of the actual horn of the Urus in existence. The curious corrugations on the surface of the lower end were similar to those found on the American and European bison, and incidentally supported the view that the white cattle of Chillingham, Chartley, and Cadzow were not descended from this animal.—Photograph of the horns of a Roberts's gazelle (*Gazella grantii robertsi*) obtained by Mr. C. L. Chevalier: O. **Thomas.**—The discovery of the skeleton of *Diplodocus carnegii,* Hatcher: Dr. W. J. **Holland.** Dr. Holland discussed the osteology of Diplodocus, briefly pointing out some of the more interesting structural features of the skeleton, and in this connection animadverted upon certain so-called "restorations" made public in popular magazines. Dr. Holland concluded his account by exhibiting in rapid succession pictures of a few of the more remarkable skeletons which had been recovered by the palæontological staff of the Carnegie Museum from various localities in the region of the Rocky Mountains.—A unique specimen of *Cetiosaurus leedsi,* a sauropodous dinosaur from the Oxford Clay of Peterborough: Dr. Smith **Woodward.** The author described the fore and hind limbs and the tail, and confirmed the observation of the late Prof. O. C. Marsh, that Cetiosaurus was one of the more generalised Sauropoda.—On a young female Nigerian giraffe: Dr. P. C. **Mitchell.** On the evidence afforded by a young female giraffe, obtained by Captain Phillips in the district of Gummel, about 300 miles due west of Lake Chad, and now deposited in the Society's Gardens, the author was inclined to believe in the distinctness of the

1 Loeb's "Ketten-reflexe," discussed in his "Vergleichende Gehirnphysiologie u. Vergleichende Psychologie," Leipzig, 1899, p. 96, and *seq.*; compare also Exner, "Entwurf einer physiologischen Erklärung psychischer Erscheinungen," Vienna, 1894, p. 102, and *seq.*, under "Successive Bewegungscombinationen."

Nigerian giraffe (*Giraffa camelopardalis peralta* of Thomas), which, however, was closely allied to the Nubian form (*G. c. typica*).—The ento-parasites obtained from the Zoological Gardens, London, and elsewhere: A. E. **Shipley.** Thirteen species were enumerated, one of which was described as new.—The muscular and visceral anatomy of a leathery turtle (*Dermatochelys coriacea*): R. H. **Burne.** The animal was a young female about 4 feet long, and was thus considerably larger than the few examples of this rare chelonian that had previously been dissected. It came from Japan. The muscles of the neck, trunk, and limbs were described in detail, and notes were made of numerous hitherto unrecorded or imperfectly described features of the alimentary and other internal organs.—A third collection of mammals made by Mr. C. H. B. Grant for Mr. C. D. Rudd's exploration of South Africa, and presented to the National Museum: O. **Thomas** and H. **Schwann.** The present series was obtained in Zululand, and consisted of 222 specimens, belonging to 49 species, of which several were described as new, besides a number of local subspecies.—Description of a new species of newt from Yunnan: G. A. **Boulenger.**—Hybrid hares between *Lepus timidus*, Linn., and *L. europaeus*, Pall., in southern Sweden: Dr. E. **Lönnberg.** The hybrids had become comparatively common in this part of Sweden owing to the introduction of the latter species for hunting purposes.—Description of the giant eland of the Bahr-el-Ghazal: A. L. **Butler.** Mr. Butler was of opinion that this eland was more nearly allied to the West African form than to that of South Africa, and proposed to distinguish it as *Taurotragus derbianus gigas.* It differed from the typical *T. derbianus* in its much lighter body-colour (a pale *café-au-lait* fawn instead of a rich ruddy brown), in the greyish white of the black-maned dewlap, and in carrying grander horns.

Chemical Society, April 19.—Prof. R. Meldola, F.R.S., president, in the chair.—Complex nitrites of bismuth: W. C. **Ball.** A series of double salts of bismuth nitrite with alkali and ammonium nitrites and nitrates were described. These salts, though unstable, appear to be perfectly definite substances.—Experiments on the synthesis of the terpenes, part ii., synthesis of Δ^3-*p*-menthenol (8), $\Delta^{3:8(9)}$-*p*-menthadiene, *p*-menthanol (8), $\Delta^{8(9)}$-*p*-menthene, and *p*-menthane: W. H. **Perkin,** jun., and S. S. **Pickles.**—Part iii., synthesis of aliphatic compounds similar in constitution to terpineol and dipentene: W. H. **Perkin,** jun., and S. S. **Pickles.**—Part iv., synthesis of Δ^3-normenthenol (8), $\Delta^{3:8(9)}$-normenthadiene, normenthanol (8), and $\Delta^{8(9)}$-normenthene: K. **Matsubara** and W. H. **Perkin,** jun. These three papers described the preparation of terpenes and related substances. The results showed that the lemon-like odour of certain terpenes is associated with the simultaneous occurrence of two ethylenic linkages, one in the ring and the other in the side chain, and that by the disappearance of the ethylenic linkage in the ring terpenes having a peppermint odour are produced. The interesting fact was also observed that when the two ethylenic linkages occupy the so-called Tiemann position with regard to each other only one of them becomes saturated by the addition of halogens, and that consequently the property of forming a tetrabromide is not distinctive of a particular class of terpenes possessing only one double bond, as has frequently been supposed.—*C*-Phenyl-*s*-triazole: G. **Young.** This compound and certain of its derivatives were described.—The resolution of *inactive* glyceric acid by fermentation and by brucine: P. F. **Frankland** and E. **Done.** In view of Neuberg and Silbermann's observations (*Ber.*, 1904, xxxvii., 339), the authors have re-examined the barium salts of *fermentation* glyceric acid and of the synthetic acid deracemised by means of brucine, and have confirmed the results obtained by Frankland and Frew and Frankland and Appleyard, which are at variance with those recorded by the German workers.—Estimation of potassium permanganate in presence of potassium persulphate: J. A. N. **Friend.** Small quantities of potassium permanganate may be estimated iodometrically in presence of potassium persulphate provided that the solution is dilute, only faintly acid, and that the iodide is added only in slight excess of the amount required to reduce the permanganate.

Royal Microscopical Society, April 19.—Dr. Dukinfield H. Scott, F.R.S., president, in the chair.—A slide of *Bacillus typhosus* and the method adopted in staining and mounting, also photomicrographs of the slide ×2500 and 5000 diameters with flagella well displayed: W. J. **Dibdin.**—On the application of the undulatory theory to optical problems: A. E. **Conrady.**

DUBLIN.

Royal Irish Academy, April 10.—Mr. F. Elrington Ball, vice-president, in the chair.—On the growth of crystals in the contact-zone of granite and amphibolite: Prof. Grenville A. J. **Cole.** Attention is directed to the growth of crystals in amphibolites when these come under the stimulus of an invading mass of granite. Garnet and hornblende may thus appear upon a larger scale than that adopted by them in the original amphibolite. Hornblende especially grows in large prismatic forms in the composite rocks produced along such junction-surfaces, and serves as evidence in these cases that contact-alteration has taken place rather than dynamic metamorphism. Under dynamic influences, the secondary hornblende is of the granular type common in epidiorites. The instances quoted are from both sides of the Gweebarra estuary in Co. Donegal.

PARIS.

Academy of Sciences, April 25.—M. Poincaré in the chair.—Two observations relating to the undergrowth in woods: P. **Fliche.** Certain forms of plants requiring plenty of light for their proper development appear to die out when the undergrowth reaches a certain height. After clearing, however, these plants again re-appear at the same spots, and as an example of the great persistence of such plants the author instances groups of *E. lathyris,* probably planted by the Romans, which are found near Gallo-Roman remains.—On a new clutch: le **Duc de Guiche** and Henri **Gilardoni.**—On the light emitted by crystals of arsenious anhydride: D. **Gernez.** The author has made a careful study of the luminous phenomena produced during the crystallisation of arsenic trioxide, and finds that, contrary to the statements of Rose, the light is not produced at the moment each minute crystal is deposited on the sides of the flask, nor during its growth, but that the least contact between a hard body and a recently formed crystal, or between two crystals, causes a brilliant evolution of light. It is a case of the development of light by the fracture of crystals, many examples of which are known in the field of organic chemistry. This property of arsenic trioxide crystals is not a fugitive one, but is exhibited after a long interval of time.—On the application of the methods of interferential spectroscopy to the solar spectrum: Ch. **Fabry.** A description of a modification of an arrangement given in an earlier paper. It possesses the advantage of allowing a larger number of lines to be studied, and may be of use in determining very small displacements of lines.—On the variations of lustre given by a Crookes's tube: S. **Turchini.** The brightness of the fluorescent screen, when acted upon by a given Crookes's tube, was measured photometrically, each of the constants of the circuit being varied in turn. The luminosity of the screen increased with the equivalent spark up to a spark length of 10 cm. to 12 cm., after which it remained constant. Measurements were also made of the effect of the frequency of the contact breaker, of coils differing in size, and of variations in the self-induction of the coil.—The application of the microscope to the examination of india-rubber: Pierre **Breuil.** It was found that the progress of the vulcanisation of rubber could be followed under the microscope, the absorption of the sulphur being accompanied by changes in the crystalline structure.—The floral diagram of the Cruciferæ: M. **Gerber.** The floral formula of the Cruciferæ is given as

$$S(2_l+2_m).P(4_d).E(2_l+4_d).C(2_{ls}+2_{mf}).$$

—The experimental production of the ascospore apparatus of *Morchella esculenta*: Marin **Molliard.** From the experiments described the best conditions are worked out for the cultivation of this mushroom.—Chlorophyll assimilation in young shoots of plants; applications to the vine: Ed. **Griffon.** Boussingault, in 1807, studied the question

as to whether young shoots, almost colourless, possessed the power of decomposing carbonic acid, his experiments leading to a positive result. The method used was indirect, the assimilation being proved by the evolution of oxygen. The author has taken up this question again, using the method of gaseous exchanges in a confined atmosphere containing from 5 per cent. to 10 per cent. of carbon dioxide. In the cases studied the assimilation was extremely small, and was easily masked by the respiration.

CALCUTTA.

Asiatic Society of Bengal, April 5.—The colouring principle of the flowers of *Nyctanthas arbor tristis*: E. G. **Hill.** The author describes the uses of the flowers of the "Narsinghar" plant in dyeing, and gives an account of the separation and properties of the crystalline yellow colouring matter. A sweet principle, recognised as mannitol, and wax were also extracted from the flowers.—On some forms of the Krīs hilt, with special reference to the Krīs Tádjōng of the Siamese Malay States: N. **Annandale.** The Krīs is the most characteristic weapon of the Malays, but its origin is probably not very ancient. The hilt takes various forms, all of which, however, have much in common, and can be reduced to one general type. Examination of a series of specimens shows that this type was originally Hindu.—On the occurrence of the fresh-water worm Chætogaster in India, with a diagnosis of a species from Calcutta and notes on its bionomics: N. **Annandale.** The genus Chætogaster does not appear to have been recorded hitherto from India. A species (*Chaetogaster bengalensis*, sp. nov.) common in the Calcutta tanks lives in close association with water-snails, but is not parasitic upon them, feeding on small Crustacea. It progresses by the aid of an anterior and a posterior sucker, and uses its setæ in insinuating itself between the snail and its shell.

DIARY OF SOCIETIES.

THURSDAY, MAY 4.

ROYAL INSTITUTION, at 5.—Flame: Sir James Dewar, F.R.S.
CHEMICAL SOCIETY, at 8.—The Synthesis of Substances Allied to Adrenaline: H. D. Dakin.—Methylation of *p*-Aminobenzoic Acid by Means of Methyl Sulphate: J. Johnston.—Some Notes on Sodium Alum: J. N. Wadmore.—Camphoryl-ψ-Semicarbazide: M. O. Forster and H. E. Fierz.
RÖNTGEN SOCIETY, at 5, (1) to Medical Members only. Forty-two Cases of Ureteral Calculus Diagnosis by X-Rays proved by Operation on the Passage of the Calculi; (2) at 8.15 p.m., to the General Meeting, Measurement and Technique in Therapeutic Dosage: Dr. C. Lester Leonard, Philadelphia.
LINNEAN SOCIETY, at 8.—Œcology: its Present Position and Probable Development: A. G. Tansley.—The Flora of Gough Island: R. N. R. Brown.
CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 7.30.—Annual General Meeting.—At 8.—Card-Indexing and Filing: J. C. Osborne.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion on A. M. Taylor's paper "Standby Charges and Motor Load Development."

FRIDAY, MAY 5.

ROYAL INSTITUTION, at 9.—Problems underlying Nutrition: Prof. H. E. Armstrong, F.R.S.
EPIDEMIOLOGICAL SOCIETY, at 8.30.—Discussion on Dr. Buchanan's paper on The Spread of Smallpox occasioned by Smallpox Hospitals during 1900-1904: Dr. Newsholme.
GEOLOGISTS' ASSOCIATION, at 8.—Explorations for Fossil Bones in Western North America, with Special Reference to the Skeleton of Diplodocus, of which a Plaster Cast is now being Mounted in the British Museum (Natural History): Dr. W. J. Holland.

SATURDAY, MAY 6.

ROYAL INSTITUTION, at 3.—Moulds and Mouldiness: Prof. Marshall Ward, F.R.S.

MONDAY, MAY 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Nile Provinces and Western Uganda: Lieut.-Col. C. Delmé-Radcliffe.

TUESDAY, MAY 9.

ROYAL INSTITUTION, at 5.—The Study of Extinct Animals: Prof. L. C. Miall, F.R.S.

WEDNESDAY, MAY 10.

SOCIETY OF ARTS, at 8.—The Native Races of the Unknown Heart of Central Africa: The Viscount Mountmorres.
GEOLOGICAL SOCIETY, at 8.—The Geology of Dunedin (New Zealand): P. Marshall.—The Carboniferous Limestone of the Weston-super-Mare District: F. Sibly.

THURSDAY, MAY 11.

ROYAL SOCIETY, at 4, Election of Fellows.—At 4.30, *Probable Papers*: On the Resemblance existing between the "Plimmer's Bodies" of Malignant Growths and certain Normal Constituents of Reproductive Cells of Animals: Prof. J. B. Farmer, F.R.S., J. E. S. Moore, and C. E. Walker.—The Effect of Plant Growth and of Manures upon the Soil: the retention of Bases by the Soil: A. D. Hall and N. H. J. Miller.—A Study of the Process of Nitrification with Reference to the Purification of Sewage: Miss H. Chick.—Pathological Report on the Histology of Sleeping Sickness and Trypanosomiasis; with a Comparison of the Changes found in Animals infected with *T. gambiense* and other Trypanosomata: Dr. A. Breinl.—(1) The Experimental Treatment of Trypanosomiasis in Animals; (2) Remarks on Mr. Plimmer's Note on the Effects produced in Rats by the Trypanosomata of Gambian Fever and Sleeping Sickness: Dr. H. Wolferstan Thomas.
ROYAL INSTITUTION, at 5.—Flame: Sir James Dewar, F.R.S.
SOCIETY OF ARTS, at 4.30.—The Manufactures of Greater Britain. III. India: H. J. Tozer.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telephone Traffic: H. L. Webb.
SOCIOLOGICAL SOCIETY, at 8.15.—Some Guiding Principles in the Philosophy of History: Dr. J. H. Bridges.
MATHEMATICAL SOCIETY, at 5.30.—On the Intersections of two Conic Sections: J. A. H. Johnston.—On a System of Conics yielding Operators which Annihilate a Cubic and its Bearing on the Reduction of the Cubic to the Sum of four Cubes: H. G. Dawson.

FRIDAY, MAY 12.

ROYAL INSTITUTION, at 9.—The Pressure due to Radiation: Prof. E. F. Nichols.
PHYSICAL SOCIETY, at 8.—A Simple Method of Determining the Radiation Constant; suitable for a Laboratory Experiment: Dr. A. D. Denning.—A Bolometer for the Absolute Measurement of Radiation: Prof. H. L. Callendar, F.R.S.—The Resistance of a Conductor the Measure of the Current flowing through it: W. A. Price.
MALACOLOGICAL SOCIETY, at 8.—Note on *Helix pellita*, Fér., and other Shells from the Pleistocene Cave-deposits of East Crete: Rev. R. Ashington Bullen.—Notes on Recent Spanish Shells from Granada and Carmona: Rev. R. Ashington Bullen.—Description of a new Species of Vitrea from Greece: E. A. Smith.—Descriptions of new Forms of Marginellidæ and Pleurotomidæ: E. R. Sykes.
ROYAL ASTRONOMICAL SOCIETY, at 5.

SATURDAY, MAY 13.

ROYAL INSTITUTION, at 3.—Moulds and Mouldiness: Prof. Marshall Ward, F.R.S.

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THURSDAY, MAY 11, 1905.

FLOW OF UNDERGROUND AND RIVER WATERS.

Essais d'Hydraulique souterraine et fluviale. By Edmond Maillet, Ingénieur des Ponts et Chaussées. Pp. vi+218. (Paris: Librairie scientifique, A. Hermann, 1905.) Price 11 francs.

THIS treatise, which was presented in the first instance to the Academy of Sciences of Paris in 1903, is divided into two parts, the first theoretical and the second practical, to which a paper has been appended, mainly of a practical nature, on the curves of the discharge of springs and the abatement of river floods. The book is addressed to mathematicians, physicists, geologists, geographers, meteorologists, engineers, and all who are interested in the motion and the distribution of rainfall, both on the surface of the land and underground; and its object is to investigate theoretically and practically the variations in the discharge of springs, and the low-water flow of rivers, in order to be able to foretell the amount of this minimum flow, precisely as the height of the floods of rivers is predicted, as already effected in certain cases by French hydraulicians, such as Dupuit, Belgrand, Lemoine, de Preaudeau and others, and also recently by the author with respect to two of the sources of the River Vanne.

M. Maillet believes that he is the first to have indicated a method by which exact quantitative discharges can be systematically predicted, such as a graphic curve, based upon Dausse's law concerning the permeable strata of the Seine basin, enabled him to determine the yearly minima discharges of two sources of the Vanne several months beforehand. Later on, by means of the hypothesis of a particular form of the free water-surface, he succeeded in obtaining a law which proved to be in accordance with experience, as indicated in the first half of the theoretical portion of the book. In the second half of this portion, the stability, or the nature of the motion of underground waters, under different conditions, is investigated, allowing for the increase in volume produced by rain; and assuming a simple form for the impermeable bed over which the water flows, it is shown that where the line of the bed is convex upwards the maximum height of the flood will be rapidly attained, and where concave, the flood will rise slowly, and that the influence of a part of the stream on the maximum will be greater in proportion to the fall of the bed. The connection, also, between the low-water levels, or minima discharges, at any point of a watercourse or spring and the rainfall, is considered in as general a form as possible; and it is proved that, in practice, the lowest discharge may often be regarded as a function of the combined rainfall of the preceding hot and cold seasons, and experiences very slight variations from year to year, especially in large river basins, unless the warm season is very rainy and impermeable strata intervene.

The results of the theoretical investigations comprised in the first six chapters are summed up in the three following laws:—(1) A certain number of hydrological facts, corresponding to the low stages, or minima discharges, of springs or watercourses, in many cases depend almost exclusively on the total rainfall of several preceding warm and cold seasons. It is only in the case of restricted watersheds that the rainfall of the last one or two cold seasons exercises a predominating influence, the number of preceding years on which the results depend increasing in proportion to the size of the basin. The preceding warm seasons have less influence than the following cold seasons; and they both have less influence in proportion as they date further back, though this loss of influence varies inversely with the size of the basin. The immediately preceding spring and summer rainfalls may introduce an element of disturbance if they are heavy and widespread, supposing that the permeable strata predominate in the basin; but where the basin is almost wholly permeable, the rainfall of the preceding warm seasons may often be neglected. (2) The lowest level at a given point of a watercourse in any year is approximately a function of the minimum level of the preceding year, and of the amount of rain during the preceding cold season, and some preceding months of the warm season if very wet or very dry, provided the proportion of impermeable strata in the basin is small. In the case of many watercourses, the minimum yearly level varies little from year to year; and a succession of several years, or several cold seasons, more rainy or more dry than the average, is needed to produce modifications, which, moreover, are slow and progressive with the lapse of time. (3) In the Seine basin, the low-water levels at given points of many of the watercourses draining almost wholly permeable strata, differ little from their mean secular height. These variations cannot be abrupt, except under the immediate influence of rainy summers on the impermeable strata of the basin; and in any case they would be progressive, as a result of a gradual increase in the mean rainfall for a certain number of years. Subject to these reservations, an appreciable variation in the low-water level must be due to other than meteorological causes.

The second, practical, part of the book occupies little more than a third of the space devoted to theoretical considerations, though divided into ten chapters, which are, consequently, very short for the most part. It contains some practical applications of the views and theories developed in the first part, to the prediction of various hydrological phenomena, and also some experimental verifications; and the works of Belgrand, and the observations and publications of the hydrometric service of the Seine basin, form the basis of this inquiry. After a very brief introduction, the chapters deal successively with proportion of rainfall which feeds underground waters, prediction of the drying up of the sources of the Somme from the rainfall, prediction of the discharges of Cérilly spring, a source of the Vanne, prediction of the minima discharges of the sources of the Vanne, application to the sources of the Dhuis, prediction of the low-water levels of the Marne at La Chaussée, drying up of the Laignes, remarks on springs supplying Havre, and

great floods of the Seine; and thirty-one tables are appended at the end of the volume, giving the rainfall, discharges, and water-levels at different dates in various parts of the Seine basin, and eleven sets of graphic curves indicating the decrease in the discharges of the Seine, some of its tributaries, and certain sources, at different periods. Table xxiii., giving the rainfalls of the warm seasons, and the high floods of the following cold seasons, at the Austerlitz Bridge, Paris, and at Mantes, from 1874 to 1900, shows that none of these warm seasons in which the rainfall was below the mean of 14.88 inches, was followed by floods of the Seine rising higher than 14.44 feet on the gauge at Paris, and 19.72 feet at Mantes; and the eight cold seasons in which the Seine reached or exceeded 16.40 feet at Paris, and 21.06 feet at Mantes, were all preceded by warm seasons in which the rainfall exceeded the mean. Moreover, with the exception of 1890, when the warm season came between two very dry cold seasons, all the warm seasons having a rainfall above the average have been followed by floods of the Seine, attaining at least 10.17 feet at Paris and 16.40 feet at Mantes; whereas none of the fourteen warm seasons with a rainfall below the average was succeeded by floods in the next cold season, reaching the height attained in eight of the cold seasons preceded by warm seasons in which the rainfall exceeded the average.

A NEW AMERICAN WORK ON THE CALCULUS.

Elements of the Differential and Integral Calculus. By William Anthony Granville, Ph.D., with the editorial cooperation of Percey F. Smith, Ph.D. Pp. xiv+463. (Boston and London: Ginn and Co.) Price 10s. 6d.

THIS is a book the main object of which seems to be to enable the student to acquire a knowledge of the subject with little or no assistance from a teacher; and, after a very careful study of it, we are enabled to say that the work is admirably constructed for the purpose. There is a complete absence of the stilted formality which is usually supposed to be appropriate to a mathematical treatise. In foot-notes, and sometimes in the text, the student is given scores of useful hints and warnings against errors into which he would probably fall. Thus the work possesses a very high value for the student; and it will be found no less helpful to the teacher, for it contains a very large number of examples in every part of the subject, while it abounds in excellent diagrams.

The portion on the differential calculus occupies 285 pages, and terminates with 6 pages containing nothing but figures of all the curves more or less famous which present themselves in the subject, such as the conchoid of Nicomedes, the cycloid, the catenary, the cissoid of Diocles, the probability curve, various spirals, &c.

The work is very strictly logical in its method—here and there a little too much so, perhaps.

Thus in p. 97 the proof that the angle between the radius vector and the tangent to a curve has $rd\theta/dr$ for its tangent is quite unnecessarily accurate, and has involved an error in work, which, however, is a mere slip. The theorem of mean value is very well explained and used in the deduction of Taylor's theorem for the determination of the remainder, a little geometrical figure assisting the student to understand the nature of this remainder. (Correct, however, the errors in sign in the first equation of p. 169.)

The discussion of the convergency and divergency of series is very good, and a somewhat uninteresting subject is rendered simple and attractive. An incautious statement, however, is made with regard to an alternating series, p. 241, according to which if we stop at the nth term of such a series the error made is numerically less than the value of the $(n+1)$th term. Clearly this is not in general true if the alternating series is one in which the numerical values of the terms increase for a while and then diminish. For example, the series for sin x is an alternating one of this kind. If $x=5$, the numerical values do not begin to diminish until after the third term. The property asserted, and the proof in p. 226, must be applied to cases in which we stop after the greatest numerical term has been passed.

The theory of maxima and minima is well illustrated by examples taken from various branches of physics. Even at the risk of being a little hypercritical, we must, however, point out that the time taken by a ball to roll down a plane the base of which is of length a and the inclination of which is ϕ is not $2\sqrt{a/g}$ sin 2ϕ, as it is said to be in p. 128, for the simple reason that the acceleration of the centre of the ball (if the ball is solid and homogeneous) is not g sin ϕ, but $5/7$ g sin ϕ. This fact is of importance in dynamics, and the matter should be set right.

The part of the book dealing with curves is very good, and, in particular, we would commend the systematic manner in which (pp. 267, 268) the student is taught to trace a curve from its equation.

In the portion dealing with the integral calculus an exhaustive exposition of all the devices used in integrating functions is given. The reduction formulas to be applied to the binomial integral $\int x^m(a+bx^n)^p dx$ are given in tabular form on p. 345, and the student is told very properly that he should not memorise them. Instead of memorising them, he should apply a single simple rule which was given long ago by Hymers in his "Integral Calculus." This rule enables us to obtain, without an effort of memory, the exact formula appropriate to the reduction of any given binomial integral.

Besides areas and volumes (accompanied by excellent figures), polar moments of inertia of plane areas are dealt with. The author speaks of these as moments of inertia about "a point"—an expression which leaves something to be desired, since it is always an *axis* that is involved. What we always require in this connection in dynamics is the *mean square of distance of a body from an axis,* and we should look to writers on the calculus to emphasise this notion of a mean square of distance, instead of the "square of the radius of gyration," k^2. The

student might easily learn to regard k as the *distance of mean square*, just as we speak of the *velocity of mean square* in a gas.

The book has a useful chapter on the simpler forms of differential equations, and concludes with a figure and description of the integraph for finding the area of a curve. It might well include a description of Amsler's planimeter, and show how it finds areas, positions of centres of gravity, and moments of inertia of plane figures; and, as to the proof of the theory of Amsler's planimeter, it need occupy no larger space than the area of a shilling, notwithstanding the length and complication of proofs which are usually given.

The author's attention may be directed to the following misprints:—p. 44, note, Leibnitz was Gottfried, not Gottfreid; p. 206 (A), read f'_x for f_x; p. 216, ex. 15, read v_0^2 for v_0; p. 225, line 5, read 223 for 225; p. 275, line 6, read P′ for P; p. 374, line 1, read y for dy.

GEORGE M. MINCHIN.

SERUM DIAGNOSIS.

Manual of Serum Diagnosis. By O. Rostoski. Authorised translation by Charles Bolduan. Pp. vi+96. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 1 dollar.

THIS small work forms a companion volume to that by Wasserman on "Hæmolysins and Cytotoxins," which has already been noticed in these columns. Each volume forms a monograph on some part of those newer developments of bacteriology which concern immunity and kindred subjects. The aim of the series is to provide simple yet comprehensive accounts of our present knowledge suitable for those who do not make a special study of the laboratory aspects of disease rather than exhaustive treatises adapted for special students. That the information is authoritative and trustworthy is vouched for by the list of authors, which includes some of the most distinguished names in contemporary bacteriology. Each volume is the work of one who has himself made important contributions to the study of the subject.

The present volume deals with the practical use of agglutinins, bacteriolysins, and precipitins in diagnosis. More than two-fifths of the whole is devoted to an account of the Widal reaction in enteric fever. This section is extremely good, and for it alone the book is well worth reading. The author points out very clearly that the "test" is not to be regarded as more than the "first of the cardinal symptoms of typhoid." Some discredit has been cast on the value of the reaction, because clinicians have not always found that infallibility which is so often expected of the laboratory, but which can never be present in dealing with so variable a complex as living matter. Removed from the pedestal of a "test" to the common ground of a "symptom," the phenomenon seems to have a better chance of receiving the appreciation which it deserves. There is an admirable account of the mixed and "group" agglutinations in typhoid and paratyphoid infections, and due notice is taken of the use of typhoid cultures which have been killed by the addition of formalin. These react practically as well as living cultures; and, though the increased time required to obtain a result and the slight loss of delicacy render the use of living cultures still desirable in the laboratory, the safety and convenience of the dead cultures place the "test" within the personal practice of every not-too-busy practitioner. It is, however, strange to read (p. 13) that the use of an oil-immersion objective is necessary.

The author then considers briefly the agglutination phenomena found in tuberculosis, dysentery, and other diseases. Serum diagnosis of tubercle is considered to be of very doubtful value. Appropriate stress is laid on the fact that in many diseases (especially plague and cholera) agglutination, in comparison with other symptoms, is of very little use for the direct diagnosis of the disease, though of the greatest value in the identification of the isolated organism. This part of the book is, however, less satisfactory than the earlier sections. Indeed, the serum diagnosis of Malta fever is not mentioned, though the practical value of the phenomenon in the diagnosis of this variable and often very obscure disease has been demonstrated beyond question.

The book concludes with an account of the identification of blood stains by the precipitin test. Readers will find here a wise injunction to make sure that any given stain is blood before deciding whether it is of human or animal origin; the precipitin will not distinguish between the different tissues of the same species of animal in the same way as it will separate the same tissue from different species.

In the translation several useful additions have been made; the last chapter, which attempts an impossibly precise and entirely arbitrary definition of the Widal reaction, might, however, well have been omitted.

A. E. B.

HISTORY OF PHARMACY.

Geschichte der Pharmazie. By Hermann Schelenz. Pp. ix+934. (Berlin: Julius Springer, 1904.) Price 20 marks.

THE successful practice of pharmacy implies some acquaintance with plant chemistry and with that branch of economic botany known as *materia medica*. For this reason the history of pharmacy, although it appeals particularly to the pharmacist and the physician, presents also many points of interest to the chemist and the botanist. Herr Schelenz does not consider that the classes of readers here enumerated form a sufficiently wide circle for his purpose, and he states in the preface to this volume that he hopes also to interest the legislator, the antiquarian, and the philologist.

The book begins with a description of the conditions under which pharmacy was practised among the Jews. A summary of the political history of the nation is first given, and this is followed by sections dealing with Biblical and Talmudic references to the practice of pharmacy and the social condition, &c., of the practitioners of the art. The most interesting portion of this section is that describing the drugs employed by Jewish apothecaries. It is curious that so many of these are still in use at the present day;

for example, myrrh, Indian hemp, cassia (or cinnamon), coriander, colocynth, galls, almonds, galbanum, and storax are among those mentioned by the author. The Jews also appear to have made use to some extent of natural mineral waters and various medicated baths as remedial agents.

Similar accounts of the practice of pharmacy among the Phœnicians, Assyrians, Egyptians, Hindus, Persians, Greeks, Romans, and other peoples are given, and then this racial method of treatment is interrupted, and a chapter is inserted giving an account of the methods of the professors of magic, astrology, and alchemy in the Middle Ages, and showing how the practice of these secret arts gradually led to a knowledge of natural science.

Resuming his narrative after this digression, the author deals with pharmacy among the Copts and Syrians, the Arabs, and the Teutonic races, and brings it to the close of the eighteenth century with a short account of the condition of medicine and pharmacy in Italy, when the school of Salermo exercised a paramount influence on these arts. It was at this period that a definite separation of pharmacy from medicine first took place.

Each of the succeeding chapters deals with the progress made during a particular century, an outline of the additions to physical, chemical, and botanical sciences being first given, with short biographies of the more famous exponents of these sciences. The bearing of these discoveries on pharmaceutical methods is then outlined, and finally the legislation of the periods, the social and commercial conditions, and other matters in so far as they affected the practice of medicine and pharmacy are discussed.

The book is evidently the outcome of much literary and antiquarian research on the part of its author, but it is unfortunate that more care was not exercised in selecting the material to be included. There is no reason why so much space should be taken up in recounting the political and religious histories of the various peoples. Similarly, the short and necessarily inadequate biographies of eminent men of science, which are scattered broadcast through the second half of the book, might well have been omitted, since they are already better done elsewhere. By omitting these and other not strictly relevant matters, the size of the volume could have been much reduced, and at the same time it would have been unnecessary for the author to write in the compressed, unreadable style which now characterises the book. As it is, the volume can only be regarded as a useful work of reference on the history of pharmacy and allied subjects, and to this purpose its index (26,000 entries) is well adapted.

T. A. H.

OUR BOOK SHELF.

Guide to the Gallery of Birds in the British Museum. Pp. iv+228; illustrated. (London: Printed by Order of the Trustees, 1905.) Price 2*s.* 6*d.*

THIS handsome volume is a new departure in the matter of "guides," so far as the natural history branch of the museum is concerned, being larger in size, more fully illustrated, different in style, and (perhaps most important of all) higher in price than those to any of the other sections. The text is, in fact, a concise synopsis of the leading groups of birds, with special reference to the specimens exhibited in the galleries. The plan of the synopsis necessarily follows the system adopted in the museum, and it would therefore be quite out of place to criticise that system on the present occasion. A similar remark applies to the fact of the illustrations (which are admirable of their kind) being taken from the stuffed specimens in the collection instead of from living birds—the guide is to illustrate the collection, and therefore it is quite right and proper that the figures of the birds should be taken from those shown in the gallery. In addition to the general synopsis, there is a guide to the series of British nesting birds. That the general plan and execution are in the main excellent cannot be denied; whether it will suit the taste—and the purses—of the public remains, however, to be seen.

When a new edition is called for, certain emendations may with advantage be made in the text. The most serious error we have detected is the statement (p. 11) that the largest Æpyornis was probably not more than 7 feet in height, whereas there are actually limb-bones in the museum itself which are nearly of these dimensions; such an error implies a want of cooperation between the zoological and palæontological departments of the museum. Of less importance, although far more embarrassing to the public, is the discrepancy between the terminations of the "orders" of ostrich-like birds in the list on p. 8 and those in the synopsis on that and the following pages. Again, we venture to think that the public will not be likely to understand the semi-scientific jargon frequently employed in the text. The expression, for instance, on p. 106, "the remarkable Australian forms constituting this order," would have been much better had the word "birds" been used in place of "forms." Neither is the construction of the sentences in all cases so good as it might be, as witness the following (p. 64):—"The appendage opens under the tongue and is largest in the male, giving the bird a very peculiar appearance. Like its allies it is an expert diver . . ."

R. L.

A Laboratory Manual of Organic Chemistry for Beginners. By Dr. A. F. Holleman. Translated by A. Jamieson Walker, Ph.D. Pp. xiv+78. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 4*s.* net.

THE preparation and properties of a number of organic compounds are dealt with in short paragraphs in a manner reminding one of the text-books of qualitative analysis, which are now so universally condemned. But little attempt is made to indicate the quantities which should be used, and no emphasis whatever is laid on the importance of making organic preparations in a quantitative manner. We even doubt whether the beginner would attain the required result in performing many of the preparations described.

It will be a sad day for the future of organic chemistry if text-books such as Dr. Holleman's come into general use; it is indeed difficult to imagine anything more calculated to encourage scamping of laboratory work. A growing complaint of the chemical manufacturer abroad at the present time is that the university graduates from the large modern laboratories are ruined by the elaborate apparatus, ready-made reagents and other time-saving appliances placed at their disposal, so that they are no longer themselves capable of facing practical problems properly or of making the best use of the ordinary technical appliances. The physical chemical epoch from which chemical science is now slowly recover-

ing has caused it to be forgotten that for successful work in chemistry it is essential that the investigator be a highly skilled manipulator. It is too often found that the best student in the examination room is all but worthless when set to perform even the simplest piece of experimental work; good workers can only be trained by the most careful and thorough grounding in making pure chemical preparations and by being taught to appreciate the importance and necessity of even the minutest details in the process. As a glance at the modern chemical literature shows, it is precisely this attention to detail which is so conspicuous a feature in some of the best work.

We fear that the book under notice would not lead the student to attach importance either to accuracy of method or to thoroughness of detail; it seems a pity even that it should have been found worth while to translate it and so add another to the legion of text-books.

Metaphysik in der Psychiatrie. By Dr. P. Kronthal. Pp. 92. (Jena: Gustav Fischer, 1905.) Price 2.50 marks.

THIS costly little work is written to ventilate a grievance. It would appear that certain authorities on mental diseases, including Kräpelin and Binswanger, employ in their works such terms as association, apperception, power of imagination, anger, and the like. These, according to our author, are metaphysical terms, and must be carefully excluded from *Psychiatrie,* which is a purely natural science. New sciences spring up like mushrooms nowadays, and it is a misfortune that those who specialise in one, or seek to exploit it, so rarely know with precision what is being done in others, even when these are most closely akin to their own darling pursuit. We fear that this writer hardly understands that the terms which he criticises are used every day in psychology with a minimum of metaphysical reference, and that he is almost bound, before he proceeds a step, to show due cause why the terminology of *Psychiatrie* should differ seriously from that accepted by ordinary psychology. In spite of his parade of footnotes and his references to such grand conceptions as that of *Allbeseeltheit,* it may be doubted if this writer is competent to discuss so general a question. At any rate, his present work does not impress one as being well arranged, clear, or convincing.

A Text-book of Physiological Chemistry. By Charles E. Simon. Second edition. Pp. xx+500. (London: J. and A. Churchill, 1905.) Price 15*s*. net.

ALTHOUGH Dr. Simon's book has reached a second edition, it is one which has been hitherto unknown on this side of the Atlantic. Dr. Simon's name is not associated with any researches in physiological chemistry, and there is nothing strikingly new or original in his book, either as regards subject-matter or arrangement. The work has, however, many excellent features. It is clearly written, and is free from inaccuracies; the sections dealing with the proteids and their cleavage products are especially good, and fully abreast of the recent advances which have been made in this important and interesting branch of the subject.

The author is conversant with chemical technique, and his descriptions of analytical processes are specially lucid. It is evident that he is a careful student of chemico-physiological literature, and more especially with that part of it which originates in Germany. This is frequently seen in the nomenclature he adopts. Thus he speaks of casein and paracasein instead of caseinogen and casein respectively as employed in most English books. Occasionally the adherence to German terms leads to confusion; for instance, the two German words Eiweisskörper and Albumine are both translated as albumins.

The work is primarily intended for students, and therefore references to literature are omitted. A desire to keep the book within a moderate compass has no doubt induced the author to leave out a consideration of many subjects which might well have been expected to find a place in it. Thus we find no reference to the important subject of immunity and its side issues, like the precipitin test for blood. The numerous investigations now in progress on the velocity of ferment action are passed over in silence. Physical chemistry has during the last decade made great progress, and many and important are its applications to physiology. Such questions as absorption, secretion, osmosis, gaseous exchanges, and electrical conductivity have all been made clearer by the work of the physical chemist; but there is no reference to any of such investigations.

The strangest and most important omissions, however, are the absence of any account of general metabolism, animal heat, and respiration.

Turning to the title-page, one searches in vain for the words vol. i., for the omitted material would easily fill a second volume of the same size. One cannot help thinking that, interesting and instructive as the book undoubtedly is, it cannot be expected to take its place as a favourite until the deficiencies alluded to are rectified.

Astronomy for Amateurs. By Camille Flammarion. Translated by Frances A. Welby. Pp. 340. (London: T. Fisher Unwin, 1905.) Price 6*s*.

MUCH that is interesting to amateur astronomers may be found in this volume. The descriptions are often discursive, but the matter is there, and in a readable form providing the reader's leisure is not too limited.

After a general exhortation to his readers to study and contemplate the marvels of the sky, the author proceeds to a study of the constellations, the stars themselves, the sun, and then the planets. Next follows a chapter on comets, containing some interesting facts concerning the ancient ideas of these "glittering, swift-footed heralds of Immensity," and a brief account of comets in general and of a few in particular. Shooting stars are then dealt with, and in chapters viii., ix., and x. the earth, the moon, and eclipses are severally discussed. In chapter xi. the more elementary methods of determining stellar distances and masses are described, whilst the next, and last, chapter is devoted to a discussion of life universal and eternal. The book contains eighty-four illustrations—the relevance of some of which is open to question—and it will be read with both interest and profit by those whose previous acquaintance with astronomical truths has been slight.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Scientific Correspondence of the late Sir George Stokes.

ARRANGEMENTS are in progress for the publication of a selection from Sir George Stokes's scientific correspondence. The letters addressed to him, which are now in my custody, show that there must be many from him to others, of permanent scientific value, to which I have not access. I shall therefore be glad if owners of letters of *substantial scientific interest* will entrust them to me, to be treated with care and ultimately returned. J. LARMOR.

St. John's College, Cambridge, May 8.

The Transposition of Zoological Names.

I WISH to say how thoroughly I agree with Mr. Lydekker in his remarks on the unwisdom of transposing zoological names, and on the confusion caused by this objectionable practice. To the instances which he has mentioned I may add the following cases relating to two well known and familiar species of animals. Linnæus called the only European hare known to him *Lepus timidus,* and for many years that name was applied to the common brown hare of Central Europe, while the northern hare, which changes to white in winter, was known by Pallas's appropriate name, *Lepus variabilis.* This was the nomenclature used by Blasius, by Bell in his "British Quadrupeds," and in all the ordinary text-books of zoology. It was, however, pointed out some years ago, first, I believe, by Lilljeborg, that the *Lepus timidus* of Linnæus had been based mainly upon the northern or variable hare, or that at all events Linnæus had confounded the two species together. In these circumstances obviously the best plan was to call the middle-European brown hare by its next given name, *Lepus europeus,* and this course has been adopted by most writers. But the advocates of unrestricted priority are not content with this, and insist upon calling the variable hare *Lepus timidus,* the consequence being that when that name is used it is impossible to know which of two perfectly distinct animals is intended by it.

Another still more objectionable transposition of two well known names has been lately suggested. Linnæus, in the *twelfth* edition of the "Systema Naturæ," gave the name *Turdus musicus* to the song-thrush and that of *Turdus iliacus* to the redwing, and these familiar terms have been used by all writers for these well known birds respectively ever since. But about a year ago it was discovered by an ardent member of the new school of priority that in his *tenth* edition of the "Systema" Linnæus had unfortunately (by some error in his MS. or of his printer) attached the diagnosis of *Turdus musicus* to *T. iliacus,* and that of *T. iliacus* to *T. musicus.* It was admitted that Linnæus had corrected the mistake in his later edition of 1760, but even Linnæus could not be allowed to correct his own errors in the face of the inviolable law of "priority." In future, therefore, it was maintained, the song-thrush must be called *T. iliacus* and the redwing *T. musicus!* This course has been actually adopted by a subsequent writer, but we may trust that it will not meet with general approval, and that the song-thrush and redwing will remain under the old names given to them by the father of scientific nomenclature in 1760, and used by every subsequent writer until 1904. P. L. SCLATER.

Modern Algebra.

THE publication of Messrs. Grace and Young's treatise on algebra will direct attention to the importance and difficulty of the theory of the concomitants of ternary and quaternary quantics in connection with plane and solid geometry. There are one or two points on which I propose to make some remarks.

In the first place, canonical forms are sometimes deficient in generality, and this will be the case whenever the form is the analytical expression for some *special* property of an anautotomic curve. Of this defect the canonical form of a ternary cubic furnishes a striking example, for it is the analytical expression for the theorem that through each of the three real points of inflexion one real straight line can be drawn which passes through one pair of conjugate imaginary points of inflexion on an anautotomic cubic curve; and since autotomic cubics do not possess this property such curves cannot be represented by the canonical form.

In the next place, anautotomic curves are not by any means the most interesting species of curves, and to go through the process of calculating their concomitants, and then specialising them for some particular species of autotomic curves, is often very laborious. In the case of unicursal quartics, many interesting results might be obtained by calculating directly the concomitants of the quantic $(*\between\beta\gamma,\ \gamma\alpha,\ \alpha\beta)^2$, and this would give results applicable to all unicursal quartics, except those which possess the five compound singularities called the tacnode, the rhamphoid cusp, the oscnode, the tacnode cusp, and the triple point. Also, since an evectant is the tangential equation of a curve which is related in a special manner to the original one, an examination of the evectants of the above quantic would lead to interesting results concerning conics and other curves connected with trinodal quartics.

In this subject geometrical methods are a powerful assistance to pure analysis. For example, let U be a ternary cubic in (α, β, γ); eliminate γ by means of the equation $\beta=k\gamma$, and equate to zero the discriminant of the resulting cubic equation in α/β. This will give a sextic equation $\Delta(k)=0$, which determines the six tangents drawn from A to the curve. The condition that the curve $U=0$ should have a node is that the equation $\Delta(k)=0$ should have a double root; hence the discriminant of this binary sextic is the discriminant of the original ternary cubic U.

Many other examples of a similar kind could be mentioned, and we may observe that from the discriminant of a binary duodecimic, all the conditions that a quartic curve should possess *point* singularities may be obtained.

April 28. A. B. BASSET.

Current Theories of the Consolidation of the Earth.

IN Lord Kelvin's philosophical and justly celebrated paper on the secular cooling of the earth (Thomson and Tait's "Nat. Phil.," vol. i., part ii., Appendix D), the assumption is made that the earth was once a fiery molten mass, liquid throughout, or melted to a great depth all round. He cites Bischof's experiments showing that "melted granite, slate, and trachyte all contract by something about 20 per cent. in freezing," and continues:—

"Hence, if, according to any relations whatever among the complicated physical circumstances concerned, freezing did really commence at the surface, either all round or in any part, before the whole globe had become solid, the solidified superficial layer must have broken up and sunk to the bottom, or to the centre, before it could have attained a sufficient thickness to rest stably on the lighter liquid below. It is quite clear, indeed, that if at any time the earth were in the condition of a thin shell of, let us suppose, 50 feet or 100 feet thick of granite, enclosing a continuous melted mass of 20 per cent. less specific gravity in its upper parts, where the pressure is small, this condition cannot have lasted many minutes. The rigidity of a solid shell of superficial extent so vast in comparison with its thickness, must be as nothing, and the slightest disturbance would cause some part to bend down, crack, and allow the liquid to run over the whole solid. The crust itself would in consequence become shattered into fragments, which would all sink to the bottom, or meet in the centre and form a nucleus there if there is none to begin with."

In adhering to these views, Lord Kelvin has been followed by Prof. G. H. Darwin (*cf.* "Tides and Kindred Phenomena of the Solar System," p. 257) and other eminent mathematicians; so that the theory that the earth consolidated by the building up of a solid nucleus through the sinking of portions of the crust of greater specific gravity is no doubt generally accepted by geologists and others interested in the physics of the earth.

Recent researches on the pressures within the planets (*cf. Astronomische Nachrichten,* No. 3992) have thrown great doubt on this mode of consolidation of the globe. The line of argument by which we reach this conclusion is a double one:—

(1) It is shown that the effect of pressure in the highly heated fluid assumed to have constituted the molten earth would have been to dissolve the portions of the sinking crust before they attained any considerable depth.

(2) The increasing density of the fluid itself would have prevented sinking of the crust below one-tenth of the radius, so that a solid central nucleus could not have been built up in this way.

To see this clearly, let us suppose that the earth were a molten mass, and that a crust of rock several kilometres in area, and a considerable fraction of a kilometre in thickness, had formed, and begun to sink in the molten fluid

by its superior gravity. What would happen to it as it descended towards the earth's centre?

The densities and pressures in the outer layers of the earth, found by Laplace's law, are as follows:—

Radius	Depth below the surface km.	Density	Pressure in atmospheres
1·000	...	2·55	1·000
0·995	31·85	2·608	8,610
0·990	63·70	2·667	16,470
0·985	95·55	2·725	25,080
0·980	127·40	2·785	33,690
0·97	191·10	2·904	51,670
0·96	254·80	3·025	70,410
0·95	318·50	3·144	89,400
0·94	382·20	3·265	109,860
0·93	445·90	3·386	130,130
0·92	529·60	3·508	152,940
0·91	593·30	3·629	175,470
0·90	657·00	3·751	198,760

The above table shows that before the mass has descended 31·85 km. (1/200th of the radius) the pressure about it would have become more than 8000 atmospheres, which would force the molten fluid deep into the heated rock. The rising temperature at that depth would also rapidly dissolve the mass, and before the solid has sunk through another equal space in the viscid liquid, and thus reached a depth of 63·7 km., it seems almost certain that it would be completely dissolved.

It must be borne in mind that the solid is not much denser than the liquid; and as the liquid is highly viscous the mass would sink slowly, while the increase of temperature and pressure would conspire together in the most powerful manner to dissolve the mass and reduce it to the same temperature and density as the enclosing liquid, which would be forced into it on all sides by a pressure vastly greater than any known in our laboratories.

Even if we make the violent assumption that the sinking mass is a kilometre, or several kilometres, thick, it is difficult to see how it could continue its downward course, undissolved by temperature and pressure, below a depth approximating one-tenth of the radius, or 637 kilometres. The sinking would be quite slow, owing to stiffness of the fluid, and could hardly be accomplished to this depth inside of several days, or more probably weeks.

Moreover, before the mass reached a depth of 260 kilometres, or less than one-twentieth of the radius, the density of the molten fluid would become 20 per cent. greater than it was at the surface, owing to pressure; and when the solid mass was no denser than the surrounding fluid it would cease to sink. Or, if it had acquired a small velocity downward in the fall from the surface against the viscous resistance of the fluid, which is enormously increased by the eddy arising from the condition of continuity, it might go down a little lower until the motion was overcome by the buoyancy of the denser fluid below. Accordingly, so far as one can see, solidified crust in sinking could by no possibility go lower than one-tenth of the radius, which would hardly accomplish the building up of a solid nucleus.

In considering the effects of pressure in forcing molten fluid into the sinking solid, we have not assumed that the density would thereby be increased; for at the great temperature of the fluid it is obvious that the solid into which the hot liquid entered would be dissolved, and heat from the fluid would be conducted rapidly through the solid mass. Thus no cause seems to be overlooked which could invalidate our conclusion.

It rests primarily upon the enormous pressures known to exist at great depths in the earth, and their undeniable effect in forcing the molten fluid into any possible solid body, so as to prevent it attaining any considerable depth without dissolving; and upon the assumption that even molten rock under such forces would take approximately the density given by Laplace's law, which hardly admits of reasonable doubt.

In considering these questions heretofore, the hypothesis of incompressibility for the molten fluid has been tacitly implied or assumed. Whether such an hypothesis is justified will appear differently to different minds, but for our part we cannot hesitate in rejecting it on account of the known porosity of all matter, and its observed yielding and condensation under great forces.

On account of the difficulty in handling liquids, especially when at high temperatures, they have not been so carefully investigated in the laboratory as solids; but there remains scarcely any doubt that under planetary pressure they would all yield like sponges.

In indicating his interest in the paper on planetary pressures (*Astronomische Nachrichten*, No. 3992), one of the most eminent British mathematical physicists has pointed out that to his mind the present writer has underestimated the probability that the earth has a metallic nucleus. I have since pointed out in a letter to the editor of NATURE (April 13, p. 559) that pressure, and not metallic constitution, is the true physical cause of the earth's rigidity; for under such pressure any kind of matter would assume a hardness greater than that of steel; and as the material is above the critical temperature of every substance it is really gaseous, and would expand with incredible violence if the pressure could only be relieved.

In the *Astronomische Nachrichten*, No. 3992, I have shown that in any mass of considerable size, so condensed that the pressure amounts to millions of atmospheres, circulation at great depth becomes practically impossible, on account of the friction due to the increasing pressure as we descend within the mass. The pressure and friction which prevent circulation also prevent separation of the elements according to their densities. While it may not be possible to say that there is not an increasing amount of metals, such as iron, towards the centre of the earth, it is, I think, clear that there is no distinctively iron nucleus; for the existence of such a nucleus would imply that the earth's mass had unimpeded circulation when in a fluid state, all of which is to the last degree improbable.

When the earth was less condensed it was at lower temperature, and the elements may not have been fused; and as condensation advanced, and the temperature rose, the friction due to pressure operated with increasing intensity to destroy circulation, which would thus be restricted to the subsidence of compact masses decidedly denser than the surrounding fluid. As the fluid was necessarily at high temperature, a compact mass would soon be dissolved, and further circulation of its elements practically cease.

It seems, therefore, very difficult to escape the conclusion that the earth's interior is a magma of all the elements, the increasing density towards the centre being due primarily to pressure. If any separation of the metals from the rocks took place, it could only be near the surface where the pressure is slight; but because the rocks predominate at the surface, we must not conclude the same material does not exist abundantly in the great central nucleus of the globe.

The difference in the point of view here adopted and that held by the older school of physicists is based primarily upon the effects of pressure. While there is a certain disappointment in negative results, they are sometimes useful in leading us to new conceptions, and perhaps we may hope that further study of these difficult questions will produce results admitting of general acceptance. It should be added that the pressures for the interior of the earth, calculated in the *Astronomische Nachrichten*, No. 3992, would not be very greatly modified by any other admissible law of density.

The researches of Radau and Darwin (*cf. Monthly Notices*, Roy. Astron. Soc., December, 1899, pp. 122–3) have shown that, so far as the mathematical conditions are concerned, the law of density within the earth might depart considerably from that of Laplace. But on *physical grounds, including the incontestably steady rise of pressure towards the earth's centre, whatever be the exact law of density, and especially the observed yielding and condensation of all matter under such forces*, I hold that the true law is essentially that of Laplace, and any departure from it in the actual arrangement of the matter of the globe is likely to be extremely small and unimportant.

T. J. J. SEE.

U.S. Naval Observatory, Mare Island, California,
March 31.

NOTES ON STONEHENGE.[1]

VI.—On the Solar Observations made in British Stone Circles.

In my last notes I referred to the star observations which might be made by means of stone circles. I now pass to solar observations.

I have already pointed out that much time has been lost in the investigation of our stone circles, for the reason that in many cases the exact relations of the monuments to the chief points of the horizon, and therefore to the place of sunrise at different times of the year, have not been considered; and when they were, the observations were made only with reference to the magnetic north, which is different at different places, and besides is always varying; few indeed have tried to get at the real astronomical conditions of the problem.

The first, I think, was Mr. Jonathan Otley, who in 1849 showed the "orientation" of the Keswick circle "according to the solar meridian," giving true solar bearings throughout the year.

Fig. 14.—Maeshowe, in the foreground, and the Stones of Stenness. From "Notice of Runic Inscriptions," by James Farrer, M.P. (1862).

I wrote a good deal in Nature[2] on sun and star temples in 1891, and Mr. Lewis the next year expressed the opinion that the British stone monuments, or some of them, were sun and star temples.

Mr. Magnus Spence, of Deerness, in Orkney, published a pamphlet, "Standing Stones and Maeshowe of Stenness,"[3] in 1894; it is a reprint of an article in the *Scottish Review*, October, 1893. Mr. Cursiter, F.S.A., of Kirkwall, in a letter to me dated March 15, 1894, a letter suggested by my "Dawn of Astronomy," which appeared in that year, and in which the articles which had been published in Nature in 1891 had been expanded, directed my attention to the pamphlet; the observations had no pretension to scientific accuracy, and some of the alignments are wrongly stated, but a possible solar connection was pointed out.

I began the consideration of the Stenness circles and alignments in 1901, but other pressing calls on my time then caused me to break off the inquiry. Quite recently it occurred to me that a complete study of the Stenness circles might throw light on the question of an earlier Stonehenge, so I have gone over the old papers, plotting the results on the Ordnance map.

Now that the inquiry is as complete as I can make it without spending some time in Orkney with a theodolite, I may say that in my opinion Mr. Spence's contention in his pamphlet on Maeshowe is confirmed, although many of the alignments to which he refers in support of it prove to be very different from those he supposed and drew on the map which accompanies his paper.

The alignments on which he chiefly depended were two, one running from the stone circle past the entrance of Maeshowe to the place of sunrise at Halloween (November 1), another from the same circle by the Barnhouse standing stone to the mid-winter sunrise at the solstice.

I give a copy of the Ordnance map showing the true orientation of these and of other sight lines I have made out. From this it will be seen that observations of the sun were provided for on the days in question, and that the circles and outstanding stones were undoubtedly set up to guide astronomical observations relating to the different times of the year. Of course, as I have shown elsewhere, such astronomical observations were always associated with religious celebrations of one kind or another, as the astronomer and the priest were one.

I shall not refer to all the sight lines indicated, but deal only with those, bearing upon the Stonehenge question, which I have without local knowledge been able to test and justify.

But first we must consider the astronomical differences between the rising of a star and of the sun, by which we mean that small part of the sun's limb first visible.

It is too frequently imagined that for determining the exact place of sunrise or sunset in connection with these ancient monuments we have to deal with the

[1] Continued from vol. lxxi. p. 538.
[2] See especially Nature, July 2, 1891, p. 201.
[3] Gardner: Paisley and London.

sun's centre, as we should do with the sun half risen. As a matter of fact, we must consider that part of the sun's limb which first makes its appearance above the horizon; the first glimpse of the upper limb of the sun is in question, say, when the visible limb is 2′ high.

shown that the half-way time between an equinox and a solstice is when the sun's centre has a declination approximately 16° N. or S. In Orkney, with the latitude of 59°, assuming a sea horizon, the amplitude of sunrise or sunset is 32° 21′, the corresponding azimuth being 57° 39′.

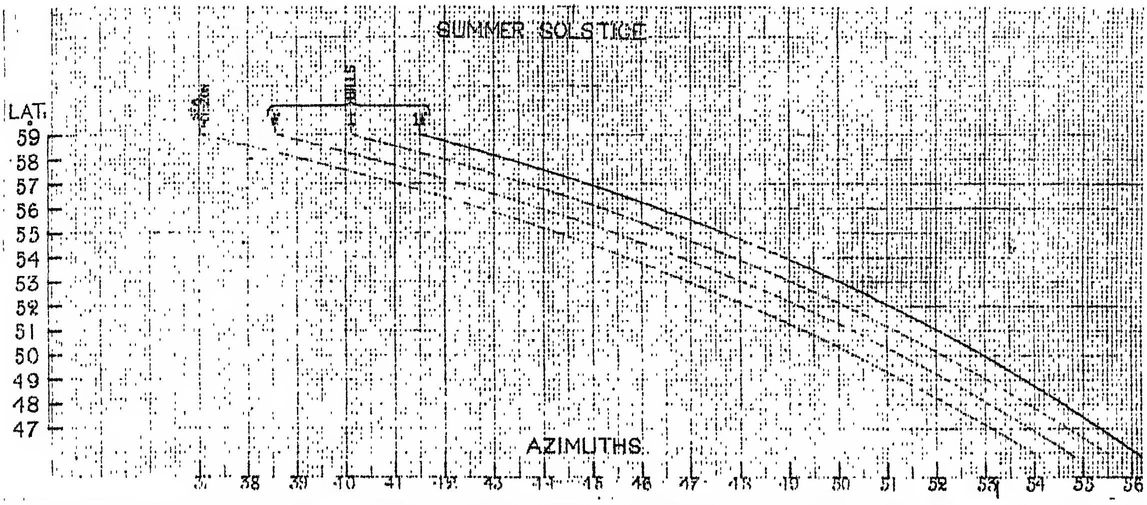

FIG. 15.—The Azimuths of the Sunrise (upper limb) at the Summer Solstice. The Values given in the table have been plotted, and the effect of the height of hills on the azimuth is shown.

To make this quite clear I give a table which has been computed by Mr. Rolston, of the Solar Physics Observatory, showing the true azimuth with hills up to 1½° high for lat. 59° N., the latitude of Stenness, and 51°, nearly the latitude of Stonehenge, of the sun's upper limb for the solstitial year.

SOLAR AZIMUTHS

	Lat. 59°	Lat. 51°
SUMMER SOLSTICE.	Rising N. of E. or Setting N. of W.	Rising N. of E. or Setting N. of W.
	° ′	° ′
1. Sun's centre; uncorrected ...	39 16	50 40
2. Upper limb; corrected for semi-diameter and refraction ...	37 1	49 20
3. ,, ,, ,, and hill ½° high ...	38 34	50 16
4. ,, ,, ,, ,, 1° ,, ...	40 8	51 12
5. ,, ,, ,, ,, 1½° ,, ...	41 30	52 4
WINTER SOLSTICE.	Rising S. of E. or Setting S. of W.	Rising S. of E. or Setting S. of W.
	° ′	° ′
1. Sun's centre; uncorrected ...	39 16	50 40
2. Upper limb; corrected for semi-diameter and refraction ...	41 24	52 0
3. ,, ,, ,, and hill ½° high ...	39 54	51 4
4. ,, ,, ,, ,, 1° ,, ...	38 23	50 8
5. ,, ,, ,, ,, 1½° ,, ...	36 54	49 14

Now the most interesting and best defined line with this azimuth on the Ordnance map is the one stretching S.E. from the centre of the Stenness circle to the Barnstone, with an azimuth of 57° 15′. The line contains between the two points I have named another stone, the Watchstone, 18½ feet high, in the precise alignment; and from the statements made and measures given it is to be inferred that a still more famous and perforated stone, the "Stone of Odin," demolished seventy years since, was also in the same line within the extremities named.

If we may accept this we learn something about perforated stones, and can understand most of the folk lore associated with them, and few have more connected with them than the one at Stenness. I suggest that the perforation, which was in this case 5 feet from the ground, was used by the astronomer-priest to view the sunrise in November over the Barnhouse stone in one direction, and the sunset in May over the circle in the other.

There is another echo of this fundamental line; that joining the Ring of Bookan and the Stones of Via has the same azimuth and doubtless served the same purpose for the May year.

But this line, giving us the May sunset and November sunrise, *not* the December solstitial sunrise as Mr. Spence shows it, is not the only orienta-

The first important thing we learn from the table is that although at any solstice the azimuths of the rising and setting of the sun's centre are the same, the azimuths of the upper limb at the summer and winter solstices differ in a high northern latitude by some 5°. The difference arises, of course, from the fact that the limb is some 16′ from the sun's centre, so that considering the sun's centre as a star with fixed declination, at rising the limb appears before the centre, and at setting it lags behind it.

It will also be seen that at sunrise hills increase the azimuth from N., and refraction reduces it; while at setting, hills reduce the azimuth from S. and refraction increases it.

Not only does calculation prove the worship of the May and June years, but I think the facts now before us really go to show that in Orkney the May year was the first established, and that the solstitial (June) year came afterwards, and this was the chief question I had in view.

I will begin with the May year. I have already

tion connected with the May year at the stones of Stenness. The November sunset is provided for by a sight-line from the circle to a stone across the Loch of Stenness with an azimuth of S. 53° 30′ W.

To apply the table to the solstitial risings and settings at Stenness, and the sight-lines which I have plotted on the map, it will be seen that the table shows us that the lines marked

N. 39° 30′ E.	S. 41° 0′ E.
N. 41° 16′ E.	S. 36° 30′ W.

are solstitial lines; to get exact agreement with the table the heights of the hills must be found and allowed for. I have roughly determined this height from the 1-inch map in the case of the Barnstone-Maeshowe alignment.

On the N.E. horizon are the Burrien Hills, four miles away, 600 feet high at the sunrise place, gradually ascending to the E., vertical angle = 1° 36′ 30″. The near alignment is on and over the centre of Maeshowe. Colonel Johnston, the Director-general of the Ordnance Survey, has informed me that the true azimuth of this bearing is N. 41° 16′ E., and in all probability it represents the place of sunrise as seen from the Barnstone when Maeshowe was erected. What is most required in Orkney now is that some one with a good 6-inch theodolite should observe the sun's place of rising and the angular height of the hills at the next summer solstice in order to determine the date of the erection of Maeshowe. Mr. Spence and others made an attempt to determine this value with a sextant in 1899, but not from the Barnstone.

The Ordnance maps give no indication of stones, &c., by which the direction of the midsummer setting or the midwinter rising and setting might have been indicated from either the Maeshowe or the Barnstone.

To sum up the solar alignments from the circle.

We have the May sunrise marked by the top of Burrien Hill, from 600 to 700 feet high, Az. 59° 30′.

We have the November sunset marked by a standing stone on the other side of the Loch of Stenness, Az. 53° 30′.

June rising, Az. true 39°. The top of Hindera field, more than 500 feet high, the highest peak, triangulation station.

December rising, tumulus (Az. 41°) on Ward Hill.

December setting, tumulus Onston 36° 30′.

General Remarks.

It is not a little remarkable that the winter solstice rising and setting seem to have been provided for at the Stenness circle by alignment on the centres of two tumuli across the Loch, one the Onston tumulus to the S.W. (Az. 36° 30′), the other tumulus being on Ward Hill to the S.E., Az. 41° (rough measurement).

It looks also very much as if the Maeshow tumulus was an after structure to use the Barnstone for the summer solstice rising; then these two other tumuli, to deal with the winter solstice at Stenness circle, may have been added at the same time. All these provided for a new cult.

There are also tumuli near the line (which cannot be exactly determined because the heights of the hills are unknown) of the summer solstice setting; none was required for the sunrise at this date, as the line passes over the highest point of Hindera field, a natural tumulus more than 500 feet high, and on that account a triangulation station.

Another argument in favour of the tumuli being additions to the original design is that the place of the *November* setting from the Stenness circle is marked, *not* by a tumulus, but by a standing stone. As the stone near Deepdale and the tumulus at Onston are only about 1200 yards apart, the suggestion may be made that in later times tumuli in some cases replaced stones as collimation marks.

NORMAN LOCKYER.

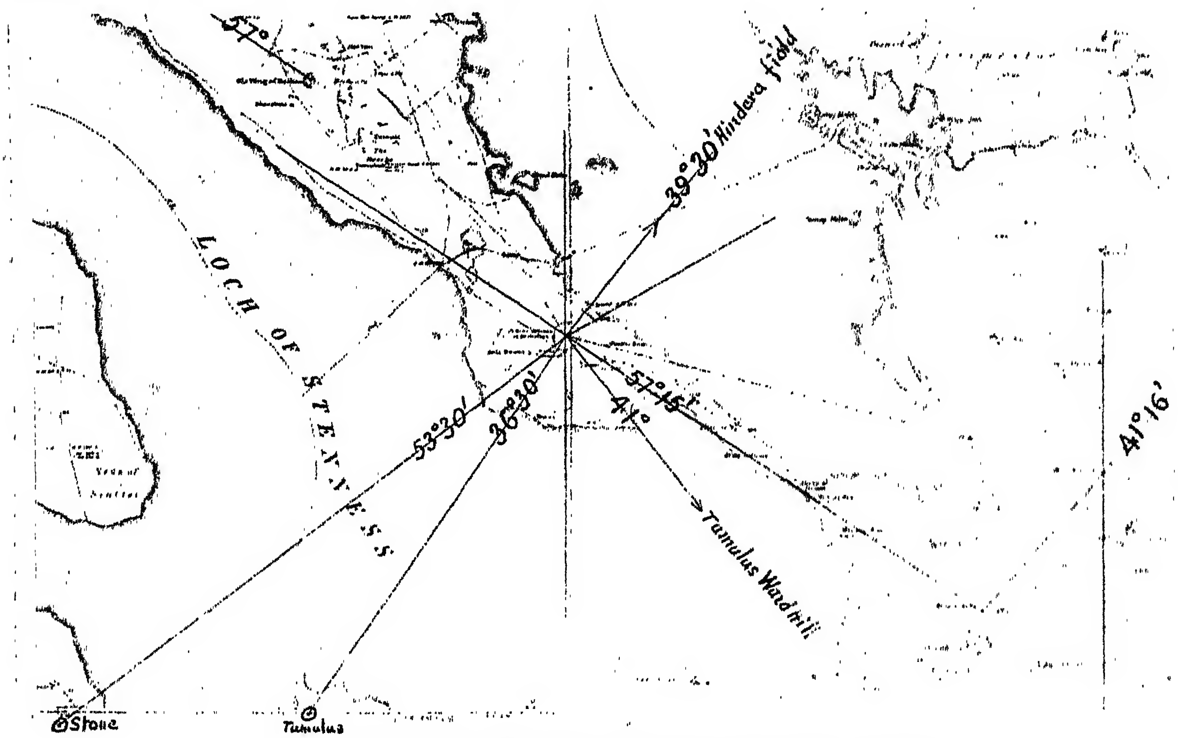

FIG. 16.—Copy of Ordnance Map showing chief sight lines from the Stones of Stenness.

SOUTH AFRICAN GEOLOGY.[1]

MR. ROGERS has produced a handbook to the geology of Cape Colony which is sure to remain a standard treatise. New observations will be recorded in future editions, as the work of his survey is carried on; but results made public as recently as 1904 are included in the present volume. The book appears with especial appropriateness, now that the visit of the British Association to South Africa has been officially organised; and the included geological map, on the scale of about one inch to ninety miles, gives an admirable impression of the country. In it we see the huge Karroo synclinal, occupying almost all the colony, and lying between the pre-Devonian masses that crop out upon the north and the closely folded rocks of the Cape system along the south; while Mr. Rogers's introduction connects the scenic features with the geological structure in a manner that attracts us at the outset.

It is unfortunate that the names chosen for the colonial systems of rocks are not readily represented by adjectives. Hence such ungrammatical expressions as "pre-Cape" and "pre-Karroo" have been received indelibly into literature. Even the International Congress may hesitate to speak of an "*étage bokkeveldien*," though we have, to be sure, "purbeckien" and "bathonien" in Europe. This use of local names is, of course, greatly to be commended, in view of the scarcity of fossils in the great majority of the series.

The invasion of the old Malmesbury beds in the west of the colony by granite is concisely described on p. 38; and it is interesting to note how gneissic structures have arisen in the granite, as in so many other instances, without "evidence of a great amount of crushing or rearrangement of its component minerals after it solidified." The foliation-planes in the gneissoid granite are parallel with the strike and cleavage of the adjacent sedimentary rocks, and the whole structure seems one of subterranean flow. The granulites of the Darling area will clearly bear comparison with those that have been so much discussed in Saxony. The intercalation of orthoclase crystals from the granite in lenticular areas between laminæ of slate (p. 43) reminds us, again, of the composite rocks of Donegal.

Mr. Rogers gives an interesting account of the stages in the passage from the well known blue crocidolite to the more siliceous yellow "griqualandite" in the slates of the Griquatown series. The slates themselves are converted into jasper-rocks where the most altered amphibole occurs; and the crests and troughs of the folds have afforded hollows in which the fibres of amphibole have crystallised across from one surface to another.

The Cape system, including the Table Mountain series at its base, has been greatly contorted and overfolded in the south; but the southern edge of the Karroo beds is also involved (p. 407), and the great east-and-west ridges of the continental margin date from somewhere about Jurassic times. Flattened and striated pebbles occur in the Table Mountain beds, and are regarded as the first evidence of a neighbouring highland on which glaciers gathered. The Devonian Bokkeveld beds follow, and the still higher and famous Dwyka conglomerate is, as all geologists know, of Permo-Carboniferous age. It is somewhat fascinating to conceive the growth of glacial conditions through at least two long geological periods, until the flood of ice at last spread southward from the Transvaal territories, and scored and rounded all the preceding rock-masses down to the region of the Cape itself.

The Dwyka beds, a facies of the Kimberley-Ecca series, and long regarded as volcanic tuffs, are here

FIG. 1.—Overfolded quartzites of the Table Mountain Series, Meiring's Poort, representative of the great upheaval, which probably took place in early Jurassic times. From Rogers's "Geology of Cape Colony."

very adequately described, with several effective illustrations. The glacial series at Vereeniging is associated with beds containing the Glossopteris flora, and also Sigillaria and other northern forms; and Mr. Rogers points out that the cold cannot have been responsible for preventing a more frequent mingling of these two well marked floras. The most novel portion of the account of the reptiliferous Beaufort beds of the "Karroo system" is the strong hint (p. 198) that they should be regarded as Permian rather than Triassic. This view, based on Amalitzky's work in Russia, would lead to a reconsideration of the Elgin Sandstone also, and to the acceptance of a development of reptilian life in Permian

[1] "An Introduction to the Geology of Cape Colony." By A. W. Rogers, M.A., F.G.S., Director of the Geological Survey of Cape Colony. Pp. xviii+463. (London: Longmans, Green and Co., 1905.) Price 9s. net.

times as surprising and swiftly various as that of the Eocene Mammalia. We presume that the Stormberg series must then include the whole of the Trias, and not merely the Rhætic, as Feistmantel and Seward have proposed. The consideration of this and similar questions is made far more interesting by the appearance of Dr. Corstorphine's address on the history of stratigraphical investigation in South Africa ("Report of the South African Association for the Advancement of Science," 1904, p. 145), to which is appended a table showing the classifications of various authors, starting with the brilliant and perceptive work of Bain in 1856.

Prof. R. Broom has provided Mr. Rogers with a chapter on the Karroo reptiles, in which the early carnivorous types, Ælurosaurus, Lycosuchus, &c., are separated from the Theriodonts as "Therocephalia." The pose given to the skeleton of Pareiasaurus in Fig. 18 is more erect than that at present adopted in the British Museum. The well known work of Prof. H. G. Seeley is mentioned later in the bibliographical appendix.

Mr. Rogers, quoting the view of Mr. Kitchin, who compares the fossils with those of similar beds in India, does not allow the presence of Jurassic strata in the Uitenhage series, so that the Jurassic system may be represented merely by the underlying unconformity (compare p. 408). The perforation of the Stormberg and preceding rocks by the diamantiferous volcanic pipes occurred, in all likelihood, in Lower Cretaceous times. The bending up of the strata round these vents presents us with a curious reminder of the old "crater of elevation" theory.

Denudation has attacked the surface of the interior of the colony "uninterruptedly from the close of the Stormberg period (Rhætic) to the present day," and the folded belt of the south seems to have furnished a fairly complete barrier against inroads of the Cretaceous sea (p. 414). A useful chapter on the geological features to be observed along the main lines of railway concludes this compact and highly attractive handbook. GRENVILLE A. J. COLE.

THE NAUMANN FESTIVAL AT CÖTHEN.

NAUMANN is but a name to nine out of ten British ornithologists, and the proportion of them who have held in hand a volume with that name on the title-page must be smaller still. Yet it was borne by two men who, taking them all round, were the most practical ornithologists that ever lived, for their personal knowledge of the birds of Central Europe was not exceeded by that of any of their contemporaries, and it may be fairly doubted whether any of their successors, vastly improved as are the modern means of acquiring such knowledge, have attained to the like acquaintance.

The elder Naumann, Johann Andreas, seems hardly ever to have quitted the little village of Ziebigk, near Cöthen, in the duchy of Anhalt, where he was born in 1744, the son of a small landed proprietor, to whose estate he succeeded. He has left a curious autobiographical sketch, which was prefixed to the first volume of the edition of the joint work of himself and his son, Johann Friedrich, published in 1822. If ever a man devoted himself to the observation and study of birds it was this Johann Andreas, who from his boyhood passed days and nights in this sole pursuit. How he found time to take a wife—for he tells us that he often forgot his dinner—is marvellous; but marry he did, and had three sons, the eldest, Johann Friedrich, already named, born in 1780, and two others; one of them, Carl Andreas, born in 1786, became a fair assistant to his father and brother, without, however, publishing anything on his own account. The father brought up these three boys to follow his own tastes and live his own life. A gun was put into their hands as soon as they could hold it, they were made familiar with every device for catching birds, and they were also taught to draw. In this last respect the eldest attained so much proficiency that by the time he was fifteen he had executed a great number of drawings of birds, which the father proceeded to have engraved on copper and to publish in folio form. The work thus produced proves to be one of the rarest in ornithological literature, if literature it may be called, seeing that not a word of letterpress accompanied the plates. Whether a complete set of them exists anywhere is uncertain, and Dr. Leverkühn's labours seem to show that not quite a dozen more or less imperfect copies are known, though there is no room here for bibliographical details. The next thing the father did was to bring out in small octavo the first volume of what was called "A Detailed Description of the Forest-, Field-, and Water-birds of the Principality of Anhalt and the Neighbouring Districts." This appeared in 1797, and was illustrated by coloured figures by the son Johann Friedrich. Some of them are reproductions of those in the older series, but the style of drawing was manifestly improved, and, moreover, went on improving as the work itself did, for it quite outgrew the bounds of its native principality, and the fourth and last volume, published in 1803, appeared as "The Natural History of the Land- and Water-birds of Northern Germany and the Adjoining Countries." This was followed by a series of eight supplements, the last of which came out in 1817. A remarkable feature of this work is its extreme simplicity and truth, and the absence of all scientific pretence. There is not even a Latin name in it! Yet there was no attempt by "writing down" to gain popularity, and whether it became popular is doubtful. All that can be said is that copies are now not easily to be had. In England when a man tries to do a thing of this kind we know too well what is generally the lamentable result. He makes a fool of himself on almost every page; but this is just what Johann Andreas did not. He wrote with quiet dignity from his own knowledge, and his knowledge was sound. There was no need for him to borrow from anybody else.

The father's work being thus successfully concluded, the son, Johann Friedrich, lost no time in bringing out a new edition of it, and it is on this edition that the latter's fame rests, and rests securely. The preface is dated 1818, and some copies of the first volume are said to bear 1820 on the title-page. Doubtless it was then ready for publication, though for some reason it seems to have been delayed for a couple of years. Twelve volumes (parts they are called) appeared at long intervals, the last in 1844, and it may be truly averred that for completeness nothing like them exists in any language. They continue the same simple and direct style of the father's work; but the son willingly cited other authors and showed that he had read them. He also extended his area of observation, journeying to Jutland in the north and to Hungary in the south, beside voyaging to Heligoland—the ornithological peculiarities of which he was the first to detect. Moreover, he discovered that anatomy was not to be neglected, and accordingly each genus as he treated of it had prefixed to it a brief account of its internal structure, and to this end he had the good fortune to obtain the services of Christian Ludwig Nitzsch, who carried on this portion of the work until his death in 1837, when his place was taken by Rudolf Wagner. Two years after the work was ended the author began a supplement, which had not proceeded far when he died, in 1857, and this was left to be completed by two of his friends, the late Prof. J. H. Blasius and Dr. Eduard Baldamus.

Carefully elaborated as this great work had been, its information had, of course, fallen behind the times, and

a natural desire was expressed for a new edition. The first part of this appeared in 1897, under the general editorship of Dr. Carl R. Hennicke, of Gera, who has been assisted by a company of thirty-six coadjutors, comprising the chief ornithologists of Central Europe, and to celebrate the recent completion of this grand undertaking in ten folio volumes a *Naumann-Feier* is to be held at Cöthen on Sunday, May 14, under the direction of Dr. Jacobi von Wangelin, of Merseburg, and Prof. Rudolf Blasius, of Brunswick, the presidents respectively of the German Bird Protection Union and the German Ornithological Society. The business of the day is announced as of the simplest character, just as one may suppose would be consonant with the wishes of the men to be honoured—an inspection of the Naumann collections, now housed in the ducal palace, a pilgrimage to the graves of the Naumanns at Ziebigk, their old abode, on which a laurel wreath will be laid, and a visit of respect to the daughter-in-law of Johann Friedrich, a return to Cöthen for a festival dinner—that is all. Who will attend I know not, but assuredly every German ornithologist will be present in the spirit, and my chief object in writing these lines is that British ornithologists should sympathise with their German brethren on the occasion. Making every allowance for the ordinary Englishman's linguistic deficiencies, it is not to the credit of our predecessors in this country, though there are many of whom we may be justly proud, that until the year 1850 not one of them seems ever to have heard of the Naumanns and their incomparable works. It was Mr. G. R. Gray who, in a British Museum catalogue, first cited that of Johann Friedrich, and then merely on nomenclatural grounds. It was there that I first met with its title, and I lost no time in seeking the work in the library of Cambridge University. Words fail me to express the delight with which I looked into one volume after another of this huge store of information, or the admiration with which I regarded its unpretentious but exquisitely executed plates. That was nearly five-and-fifty years ago, but much as the study has since advanced, the opinion I then formed I hold now, that for fulness of treatment, perspicuity, and general accuracy, the work of Johann Friedrich Naumann has not been surpassed.

Willingly would I dwell longer on the subject, but I think I may have said enough, though I must add that for many of the details above given I am indebted to two articles by Dr. Lindner published in "Die Schwalbe" of Vienna for 1894 (Nos. 7 and 8), and still more to Dr. Paul Leverkühn's excellent biographical preface to the first volume of the recent edition already mentioned, which has been separately printed, "Biographisches über die Drei Naumanns" (Gera-Untermhaus: 1904). Later still that gentleman has come into possession of much of Johann Friedrich's correspondence, which it is sincerely to be hoped he will find the means of publishing, as it can hardly fail to be of great interest.

ALFRED NEWTON.

DR. J. E. DUTTON.

IT is with deep regret that we announce the sudden death of Dr. Dutton (Walter Myers Fellow) at Kosongo, in the Congo, on February 27, while actively engaged in the investigation of trypanosomiasis and tick fever.

The expedition which Dr. Dutton was leading was a very completely equipped one, and commenced work in the Congo in September, 1903. It consisted originally of Drs. Dutton, Todd, and Christy, and was subsequently joined by Dr. Inge Heiberg. The Belgian Government erected a special hospital for them, and placed every possible facility at their disposal both for investigation and travelling. Whilst conducting the investigation and mapping the distribution of sleeping sickness and tick fever, they travelled several thousand miles by river and road, and reached a station beyond Stanley Falls.

In the death of Dr. Dutton, not only have the Tropical School and the University of Liverpool lost a brilliant graduate, but medicine has lost one of its most promising men, a man who, although only twenty-nine years of age, had already won a recognised position throughout the scientific world. Educated at the King's School, Chester, Dr. Dutton proceeded to the University of Liverpool, where he rapidly made his way to the front. In 1897 he was appointed to the George Holt fellowship in pathology, a post which has had a marked effect in stimulating men to devote time to research and in supplying able investigators in tropical medicine. In 1900 he commenced the study of tropical medicine under the leadership of Dr. Annett, and together with Dr. Elliott, of Toronto University, he proceeded to Nigeria in order to study the habits of the Anopheles and the most effective measures of prevention of malaria. In 1901 he proceeded alone to the Gambia, and drew a comprehensive and useful anti-malarial report which has proved of the greatest service to the colony. It was during this expedition that he identified in the blood of the patient shown to him by Dr. Forde, of Bathurst, the trypanosome which he described and named as *Trypanosoma gambiense*.

Having established the presence of the trypanosome in man, Dr. Dutton immediately set off on another expedition to ascertain how far it was distributed in the native population. This expedition formed the basis of his first trypanosomiasis report (Senegambia, 1902).

The first progress report of the Congo expedition was published in 1904; this has been followed by others, including the description of the "Congo Floor Maggot," by Drs. Dutton, Todd, and Christy, and the "Cerebro-spinal Fluid in Trypanosomiasis," by Dr. Christy; "A Comparison of the Animal Reactions of the Trypanosomes of Uganda and Congo Free State Sleeping Sickness with that of *Trypanosoma gambiense*," by Drs. Thomas and Linton; "Two Cases of Trypanosomiasis in Europeans," by Drs. Dutton, Todd, and Christy; and "Supplementary Notes on the Tsetse-flies," by Mr. E. E. Austen. More recently Dr. Dutton wrote an interesting paper on the "Intermediary Host of the *Filaria cypseli*" (the filaria of the African swift), in which he described the intermediate host as a louse (subfamily Leiothinæ) in the abdominal cavity of which he observed the various stages of the development of the filaria. He showed that the infection was probably spread by the birds eating the infected lice.

Toward the end of 1904 the investigators had reached Stanley Falls, and quite independently Drs. Dutton and Todd verified the discovery of the cause of tick spirillum fever in man made a few weeks previously by Milne and Ross in the Uganda Protectorate; but, furthermore, they were able to transmit the disease to monkeys and rabbits by means of the bite of the infected tick. They were able to make *post mortem* examinations on cases of the fever, in the course of which Dr. Dutton contracted the disease by a *post mortem* wound and Dr. Todd an abortive attack apparently directly through a tick bite. From this fever they recovered, in Dr. Dutton's case after four typical relapses. Their researches into the relationship between the infection in man and the tick were so far advanced that they were able to prepare a report which is due by the next mail. In the meantime, they have given an account of an experiment in which tick spirillum fever has been conveyed to a monkey by the bites of young ticks during the first feed after hatching from the ova of naturally infected adults.

NOTES.

THE gentlemen's soirée of the Royal Society will take place at Burlington House on Wednesday next, May 17.

IN a murder trial concluded last week, a finger mark left by one of the prisoners upon a cash-box tray at the shop where the crime was committed was used for purposes of identification. An inspector gave evidence that there were 80,000 or 90,000 sets of finger prints in the finger print department of Scotland Yard, and that he had never found two such impressions to correspond. The right thumb print of one of the prisoners agreed in twelve characteristics with an impression made with perspiration upon the cash-box tray, and therefore gave corroborative evidence of identity. It is probable, as Mr. Galton pointed out some years ago, that no two finger-prints in the whole world are so alike that an expert would fail to distinguish between them. The system was largely used in India by Sir William Herschel nearly fifty years ago, and was found by him to be most successful in preventing personation, and in putting an end to disputes about the authenticity of deeds. He described his methods in these pages in 1880 (vol. xxiii. p. 76); and in the previous volume (vol. xxii. p. 605) Mr. Henry Faulds referred to the use of finger-marks for the identification of criminals. There is no doubt as to the value of this system of identification, which was described in the pages of NATURE long before its practical applications had been realised, and we regret that anything should have occurred to throw discredit upon it. It appears from the reports of the trial referred to that a person who professed to be properly qualified wrote to the Director of Public Prosecutions, and also to the solicitors for the defence, offering to give evidence as an expert on the finger impressions, although he had not seen the impressions. It is not to be wondered at that Mr. Justice Channell should denounce such action in strong language, and whether the jury agreed with him or not—that the witness was "absolutely untrustworthy"—they no doubt considered that evidence which could be given on either side could not be of much importance. From the scientific point of view, we regret that a method which is associated with the names of men of such scientific eminence as Sir William Herschel and Mr. Francis Galton should be brought into disrepute. Finger prints are not only of value for personal identification, but also for hereditary investigations, and any action which produces comments like those made by Mr. Justice Channell is to be deplored, because it tends to shake the confidence of men in methods which rest on secure scientific foundations.

THE council of the Linnean Society of New South Wales has appointed Mr. Harald I. Jensen to be the first Linnean Macleay fellow.

THE *Athenaeum* announces the death of Prof. Otto Struve, who succeeded his father as director of the Nicholas Central Observatory at Pulkowa in 1861.

Science announces that Prof. L. Warren, for twenty-seven years professor of mathematics at Colby College, died on April 21, at the age of sixty-nine years.

THE *Times* understands that the trustees of the British Museum have expressed their willingness to receive carefully selected phonographic records of the voices of distinguished living men. The records will be for posterity only, and will in no circumstances be available for contemporary use.

PROF. E. B. FROST has been appointed director of the Yerkes Observatory by the trustees of the University of Chicago, in succession to Prof. G. E. Hale, who now gives his whole time to the establishment of the new Solar Observatory of the Carnegie Institution at Mt. Wilson, California.

A PARTY of zoological students from the Birkbeck College spent part of the Easter vacation trawling, dredging, and shore collecting at West Mersea, on the Essex coast. Although the temperature was very low for the time of year, many specimens were collected, and much experience was gained.

A REUTER correspondent at Bombay reports that a severe earthquake occurred at Bandar Abbas on April 25. Five shocks were experienced during the afternoon, and shocks have been occurring daily since. Sarn, a town west of Bandar Abbas, is reported to have suffered severely.

THE death is announced, in his eighty-eighth year, of Colonel N. Pike, known for his contributions to the natural history of birds, reptiles, and amphibia. For several years Colonel Pike held the post of American consul in the Island of Mauritius, and during this time he collected extensively the local fauna and prepared from the living specimens many coloured drawings. His most extended work was his "Sub-Tropical Rambles in the Land of the Aphanopteryx."

A REUTER telegram from Christiania reports that the *Belgica*, with the members of the Duc d'Orléans's Arctic Expedition on board, left Sandefjord on May 6 for Bergen, where the duke will embark. From Bergen the *Belgica* will go to Spitsbergen, Greenland, and Shannon Islands, where the Duc d'Orléans intends to visit the depôts of the Ziegler Expedition. His intention is to bring the members of that expedition back with him on the *Belgica*, and he hopes to return to Ostend in September.

THE Rome correspondent of the *Pall Mall Gazette* states that it is again proposed to affix a marble tablet to the Villa Medici, which is French property, to remind passers by and posterity that Galileo was kept prisoner there from June 24 to July 6, 1633. Italy has already erected a small monument to Galileo at the very door of the villa, with the following inscription:—"The neighbouring palace, which belonged to the Medici, was the prison of Galileo Galilei, guilty of having seen the earth revolving round the sun."

THE anniversary meeting of the Royal Geographical Society will be held on Monday, May 22. The annual conversazione will be held in the Natural History Museum, South Kensington, on Tuesday, June 27. In place of the annual dinner of the society this year, a banquet in honour of the retiring president, Sir Clements R. Markham, K.C.B., will be held on the evening of the anniversary meeting, May 22, at the Hotel Metropole.

THE Paris correspondent of the *Times* remarks that about 150 physicians and surgeons have arrived there from England, many of them with their wives and families, to return the visit which the French doctors paid to London last year. The formal reception took place last night at the Sorbonne. During the stay of the English medical men, besides the many attractive excursions and social entertainments arranged in their honour, every facility is to be given them for inspecting the hospitals.

IN proposing the toast of "The Japan Society" at its annual dinner on May 3, Sir Frederick Treves referred to the medical and surgical ability of the Japanese. Nothing

astounded him more, he said, in his recent visit to Japan than the way in which the Japanese have inquired into the medicine and surgery of the western world and the marvellous thing they are making out of it. It is difficult to credit the astonishing advance made by the Japanese in medical equipment in time of war. Many of the problems which have been the terror of war in European countries the Japanese are solving or have solved. British troops enter a war with many determinations—one of which is to have 10 per cent. of sick, and they get it. The Japanese are quite content with 1 per cent. of sick, and they get it. The Japanese have all the qualities of a surgeon. They have infinite patience and infinite tenderness. Sir F. Treves is confident that not many years hence there will be seen in Japan one of the most progressive schools of medicine the world has ever known.

THE annual congress of the South-eastern Union of Scientific Societies will be held at Reigate on June 7–10 inclusive, under the presidency of Prof. Flinders Petrie, F.R.S. Among the papers to be contributed are the following:—"Mendel's Law," Miss Saunders; "Botany of Reigate District," Messrs. R. H. Welchman and C. E. Salmon; "Local Orchids," Dr. Hodgson; "Eggs of Lepidoptera," Mr. Tonge; "The Law of Treasure Trove in Relation to Archæological Research," Dr. William Martin; "The Land and Fresh-water Shells of S.E. England," Mr. A. Santer Kennard. There will be excursions to Worth Church; Gatton; Mr. Maw's observatory, Outwood; Reigate Castle; Mr. Brown's Atherfield clay pit, &c. The Mayor of Reigate will give a reception on Friday, June 9. The congress secretaries are Mr. G. E. Frisby, Redhill, and Mrs. Taylor, Clear's Corner, Reigate, from whom all information can be obtained.

DURING the forthcoming eclipse of the sun, on August 30, aëronautical ascents will be made at Paris, Burgos, Prague, and very likely in Algeria. It is intended to study the variations, not only of the temperature of the air in the shade and in the sun, but also the solar radiation at several altitudes. If it is possible to take aërial photographs of the corona from the balloons it will be done at Burgos, and possibly at Wargia. M. Trépied, director of the Algiers Observatory, has left for Guelma, on a railway 36 miles south-west of Bona, and really a desert oasis. The sky is anticipated to be quite clear at that place, as at the end of August northerly breezes, which are very frequent on the coast, are hardly to be felt in the Sahara. The Algerian eclipse observatory will be housed in the French public school. For the last twenty years a weather bureau has been established in Algeria, and is situated on the terrace of the City Hall. The establishment is connected by telegraph with forty stations, which are sending regularly each morning observations used in the reduction of the warnings and forecasts.

LORD AVEBURY delivered his presidential address at the soirée of the Selborne Society on May 3. In the course of his remarks he referred to the animated discussion which took place recently in the newspapers as to whether Greek should be a compulsory subject in university examinations —which is euphemistically termed "maintaining the Greek basis of education against the material tendencies of the present day." It is not we, he continued, who wish to pit Greek grammar against nature-study. Greek—even a little Greek—is very useful. But nothing was said, Lord Avebury contended, about science being a compulsory subject—which alike from a practical and an educational point of view is even more important. Education without science is incomplete and one-sided, and the greatest classical scholar, if he know nothing of the world we live in, is but a half-educated man after all. Sir James Crichton Browne spoke of the value of the society's work from the point of view of mental health, while Sir John Cockburn urged the usefulness of that study of nature which is not rigidly scientific. Among the many exhibits of natural history and antiquarian interest was some honey gathered by bees in the "East End." This was shown by the Stepney Borough Museum, and it is practically certain that it was derived from sugar on the ships in the London Docks, a mile from the hive.

THE Belgian Royal Academy has issued the following lists of prize subjects for 1905 and 1906:—for 1905, in mathematical and physical sciences, on the combinations formed by halogens; on physical, particularly thermal, phenomena accompanying dissolution; on linear complexes of the third order; and on the deviation of the vertical treated from the hypothesis of the non-coincidence of the centres of mass of the earth's crust and nucleus. In natural sciences, on the function of albuminoids in nutrition; on the reproduction and sexuality of Dicyemidæ; on the silicates of Belgium; on the formations of Brabant between the Bruxellian and the Tongrian; on certain Belgian deposits of sand, clay, and pebbles; on the sexuality of the individuals resulting from a single ovum in certain diœcious plants; and on the development of Amphioxus. For 1906 the subjects in mathematical and physical sciences are:—on critical phenomena in physics; on n-linear forms ($n>3$); on thermal conductivity of liquids and solutions; and on the unipolar induction of Weber. In natural sciences, on the Cambrian series of Stavelot; on the effect of mineral substances on the assimilation of carbon by organisms; on the effects of osmotic pressure in animal life; on the tectonic of Brabant; on the soluble ferments of milk; and on the physiological action of histones. The essays for 1905 and 1906 are to be sent in by August 1 of the respective years, and the prizes range from 24*l.* to 40*l.* in value. In addition, prizes bequeathed by Edward Mailly and in memory of Louis Melsens are offered under the usual conditions for astronomy and applied chemistry or physics respectively.

THE codling-moth forms the subject of *Bulletin* No. 222 issued by the entomological division of the Michigan Agricultural College Experiment Station. This insect is a serious enemy to fruit-growers in the district, and the author, Mr. R. H. Pettit, has carefully worked out its life-history and devised effective means for its destruction.

AT the first congress of the Association of Economic Biologists, held in Birmingham University on April 19–20, Mr. A. E. Shipley directed attention to the circumstance that bacteriological and parasitical science is unrepresented on the committee appointed by Parliament to inquire into the nature of grouse-disease. The president, Mr. F. V. Theobald, emphasised the importance of closer study of the aphids affecting cultivated plants in this country, while parasites in the liver of swine, the porosity of wood, the injuries inflicted on plants by spring-tails, and ticks and fleas as conveyers of disease formed the subjects of other communications.

ARTICLE No. 4 of vol. xx. of the *Journal of the College of Science of Tokyo University* is devoted to the description of the spoon-worms (Gephyrea) of Japan, and is illustrated by one coloured and three black and white plates. The author, Mr. I. Ikeda, states that hitherto only four species of these worms appear to have been recorded from

Japanese waters, and of one of these no specimens have come under his notice. From a study extending over several years, he has been enabled to add 34 additional species to the fauna, thus bringing the number up to 38. Of the 34, no less than 24 appear to be new forms, all of which are provisionally referred to previously known generic types, although there are grounds for considering that some of those included in Thalassema might advantageously be assigned to a new genus.

SOME excellent photographs of Australian bird-life are reproduced in the March number of the *Victorian Naturalist*, among which may be specially mentioned a group of young diamond-birds (Pardalotes) and a nestling bronze-cuckoo in the act of ejecting the rightful occupant of the nest in which it was hatched. "When discovered, the nest contained two young birds. The cuckoo, blind, featherless, and apparently not more than a day old, struggling till it got beneath its victim, gradually lifted it to the edge of the nest, resting at intervals, all the while balancing the resisting nestling in the hollow between the wings immediately at the back of the neck. Slowly and relentlessly it pushed the unfortunate wren over the side. . . . The young wren was replaced in the nest half a dozen times, but always with a like result until the cuckoo was thoroughly exhausted."

Two interesting Antarctic organisms obtained during the *Scotia* Expedition are described in the *Proceedings of the Royal Physical Society of Edinburgh*, vol. xvi., No. 2. In the first article, by Dr. J. Rennie, are discussed a number of isolated tentacles of a zoophyte belonging to the group Siphonophora. The specimens are barely sufficient for definite identification, but appear to indicate a type allied to the Mediterranean Apolemia, which attains a length of two or three yards. Mr. T. V. Hodgson, in the second communication, describes a five-limbed sea-spider (Pycnogonida) distinct from *Pentanymphon antarcticum* recently described on the evidence of a *Discovery* specimen. With the assistance of Dr. Calman, of the British Museum, the author has been enabled to identify the *Scotia* pycnogonid with *Decalopoda australis*, an almost forgotten generic type described so long ago as 1837. The occurrence of two five-limbed pycnogonids in the Antarctic is, in view of the absence of this type from all other seas, very remarkable.

MR. F. FLETCHER, Deputy Director of Agriculture, Bombay Presidency, is the author of a small volume, published at Bombay, entitled "Notes on some Egyptian Insect Pests." In the autumn of 1901 the author, it appears, was engaged to teach agricultural entomology to the students at the Khedivial Agricultural School, Giza, and found himself seriously hampered in his task by the fact that practically nothing was known with regard to the insects which are harmful to the Egyptian agriculturist. Accordingly, during a two years' sojourn in the country, Mr. Fletcher set himself to study such insects whenever opportunity occurred, and the present "booklet" is the result. It contains an introduction showing the position of insects in the animal kingdom, followed by a short summary of the life-history and structure of insects in general, after which comes an account of the species forming the proper subject of the "notes." The publication seems admirably adapted to the needs of those for whom it is intended.

THE catalogue forming appendix ii. to the *Kew Bulletin* of books and pamphlets added to the library of the Botanic Gardens during the past year has been received; as usual, the printing is confined to one side of the paper only, in order that, if desired, the separate titles may be cut out.

THE collection of phenological records by teachers and pupils of schools in Nova Scotia has been proceeding for some years, and the number of schools sending in lists has been increasing. The data supplied by about 300 selected schedules in 1903 have been utilised for the compilation of phenochrons or average dates for different regions of the province, and these have been tabulated in vol. x., part xvi., of the *Transactions of the Royal Society of Canada*.

SINCE the year 1900, a gooseberry mildew, *Sphaerotheca mors-uvae*, which appears to have been introduced from the United States, has been observed in Ireland and Russia. Mr. E. S. Salmon, who reported the first appearance in Ireland, and has since notified the spread of the disease, announces in the *Journal of the Royal Horticultural Society* (vol. xxix.) its continued increase in these countries. The yellow varieties seem to suffer most. Spraying checks the fungus, but the only effectual remedy is to burn all the diseased bushes. Mr. Salmon contributes also to *Annales Mycologici* an account of a disease observed on plants of *Euonymus japonicus* in the south of England and elsewhere caused by an *oidium* or conidial stage of one of the Erysiphaceæ.

HERR PAUL GROSSER has recently visited and described the site of the Tarawera eruption of 1886, in the north island of New Zealand ("Vulkanologische Streifzüge im Maoriland," *Verhandlungen des naturhistorischen Vereins der preuss. Rheinlande*, 1904, pp. 37–58). He lays stress on the linear grouping of the eruptive centres, the ash-cones of which are almost as contiguous as pearls on a string. A fine photograph is given of a crater exploded through rhyolite on Ruawahia, with basaltic ashes covering the country above. Incidentally, Herr Grosser examined the ground affected by the Port Nicholson earthquake of 1855, which is described in the later editions of Lyell's "Principles of Geology"; and he adds the interesting detail that the elevation of the floor of a lagoon by two metres enabled it to be successfully drained into the sea, a work previously attempted, but abandoned.

THE shoal-water deposits of the Bermuda banks are described by Mr. H. B. Bigelow (*Proc. Amer. Acad. Arts and Sciences*, xl., No. 15). The oceanic character of Bermuda, due to its great distance from the neighbouring continent, prevents its receiving much foreign detritus, and its submarine deposits are almost wholly local. The great bulk of these is calcareous, with some spicules of siliceous organisms. True coral sand is absent; indeed, there is a great rarity of coral fragments, for although corals flourish on the reefs, they do so in a subordinate manner. The Bermuda plateau is of interest in illustrating the growth of a limestone island where reef-building corals are of slight importance. The organisms chiefly active in the formation of the shell-sands are corallines, molluscs, tube-building worms, millepores, and foraminifera. Algæ probably form the greatest mass of the sand. White marls are described as due to the slow trituration of wind-borne material. There are also limited areas of blue mud. This seems to be of terrigenous origin, being the fine detritus washed down by rain from the calcareous hills, with vegetable matter.

To the March number of the *American Naturalist* Dr. A. Hollick contributes a paper on the occurrence and origin of amber in the eastern United States. Although amber has for many years been known to occur in several

districts in this part of America, a discovery of the occurrence of this substance in large masses has been recently made in the Cretaceous deposits of Kreischerville, Staten Island, N.Y. The amber, which is being extensively worked for commercial purposes, occurs in a bed containing layers and masses of vegetable débris, together with lignite and pyrite. The bed appears to be lens-shaped. Some at least of the amber is presumed to be the product of sequoias, but it is possible that a species of Pinus, and perhaps a representative of the Austro-Malayan genus Dammara, may have contributed to its production. The remaining articles include one by Prof. Hallow on the structure of the vascular cylinder in hybrid catalpa trees; a second, by Messrs. Cushman and Henderson, on fresh-water rhizopods from New Hampshire; and a third, by Dr. F. W. Carpenter, on the behaviour of a fruit fly under certain stimulants.

A DESCRIPTION of the large diamond found recently in the Premier Mine, Transvaal, is given in the *Geological Magazine* (April) by Dr. F. H. Hatch and Dr. G. S. Corstorphine, with reproductions of four photographs which represent the diamond in its actual size from four

FIG. 1.—View of the Cullinan Diamond. Actual size. From a photograph by E. H. V. Melvill.

different points of view. One of these pictures is here given (Fig. 1), and it conveys a good idea of the size and shape of the crystal. The stone is bounded by eight surfaces, four of which are faces of the original crystal, and four are cleavage surfaces, which are distinguished from the original octahedral faces by greater regularity and smoothness. For a large stone the crystal is of remarkable purity, and the colour approaches that of a blue-white. The complete crystal appears to have been a distorted octahedron, with dodecahedral faces developed on the edges; and the portions missing probably amount to more than half the original crystal. The stone, which has been named the Cullinan diamond, weighs 9600·5 grains troy, or 1·37 lb. avoirdupois; this is more than three times the weight of the largest diamond previously known.

SOME account of the Mount Morgan Gold Mine, Queensland, is given by Mr. E. J. Dunn (*Proc. Royal Soc. Victoria*, vol. xvii., part ii.). The hill, which rises to a height of 580 feet, is formed mainly of igneous rocks, within which are enclosed masses of decomposed rock, made up of siliceous and ferruginous material, and overlying these is a plug of Desert Sandstone, nearly 100 feet thick in places. The sandstone occupies a hollow in loose sandy beds overlying a ferruginous layer, and these beds yielded the rich secondary ore for which Mount Morgan has been celebrated. No naturally formed gold is known that more nearly reached chemical purity. At a much lower depth, in what is known as the sulphide zone, the gold is much alloyed with silver. The silver was got rid of in the transference of the leached ore to the enriched zone. The state of subdivision of the gold in this zone was so extreme that rich samples, in some cases those carrying 50 oz. per ton, showed no traces of gold that could be detected by the naked eye. The author attributes the formation of the secondary ore to the mechanical and chemical action of sea-water on the sulphide ore, there being evidence of considerable local erosion before the horizontal beds of Desert Sandstone were laid down.

THE Canadian Department of Marine and Fisheries has published the meteorological results obtained at the magnetical observatory at Toronto for the year 1904, with remarks, in a handy and useful form. The monthly means are in most cases compared with an average of sixty-four years, and are consequently of considerable value. The mean temperature of the year 1904 was 42°·2, being 2°·2 below the average. The maximum daily mean was 78°·9, on July 18, and the coldest day −8°·5, on January 14. The rainfall measured 30·04 inches (3·05 inches above the yearly average); this amount does not include 56·5 inches of snow, which is measured quite separately from rain.

AN important step for the promotion of New South Wales meteorology is recorded in the *U.S. Monthly Weather Review* (vol. xxxii., No. 11, p. 518). It seems that the principal newspaper of the colony, the *Daily Telegraph*, has commenced the publication of a daily weather chart. The origin of this step is stated in the following brief extract from the first number of the paper which contained this new information, a more complete account of which is inserted in the *Weather Review* referred to above:—"The inclusion of meteorology in the new public schools syllabus has directed special attention to consideration of weather conditions. Correspondents, including a number of public school teachers, have applied to the *Daily Telegraph* for amplified daily information on this subject, and the meteorological branch of the Sydney Observatory also has been requested to furnish details of the weather conditions and atmospheric pressures, the information upon which the weather forecasts are made. The *Daily Telegraph* has arranged to publish daily a chart showing the principal features of weather conditions, including the high and low pressure isobars. Where possible the rainfall area will be indicated and conditions on the coast will also be given. . . . The publication of isobaric charts will enable students with their local knowledge of physical surroundings to anticipate in detail their probable weather more completely than is possible at the central

office, where precise knowledge of local peculiarities is lacking." Those acquainted with Australian meteorology will appreciate the importance of disseminating a knowledge of this valuable factor in Australian welfare. In many countries the absence of public interest in the science of the weather is due to its omission from all school instruction, and we in Great Britain are suffering from the same neglect.

THE current number of the *Fortnightly Review* contains an article by Major B. Baden-Powell, president of the Aëronautical Society, entitled "Air-ships and M. Santos Dumont." Major Baden-Powell supplements and criticises a contribution by M. Santos Dumont to an earlier number of the same review on air-ships. He also points out some of the advantages to be gained by flying machines not dependent on a light gas to lift them, and directs attention to a few of the drawbacks inherent in the large gas-bag. The attainment of human flight, he contends, apparently presents no insuperable difficulties. "All that is wanted, so far as I can see, is a few thousand pounds and a clever and energetic inventor, and there is no reason why a machine could not be constructed within a year or two capable of rising and carrying a man in safety for, at all events, a short trip through the air."

THE water jet affords a most convenient method of applying the power carried by high-pressure water, whether for driving wheels, such as are generally known as Pelton wheels, for conveying the water itself into burning buildings, or for the destructive process of breaking down a mountain side, as practised in hydraulic mining. All this is especially the case in mountainous country where water supply with almost unlimited head is available. As it is not always necessary that the jet should work at full power, regulation becomes necessary. Merely reducing the flow of water by throttling elsewhere than at the jet would be ruinously wasteful, for half the flow would carry one-quarter the power, and a driven wheel would no longer run at the proper speed. The regulating nozzle described in a thesis entitled "An Investigation of the Doble Needle Regulating Nozzle," by H. C. Crowell and G. C. D. Lenth (printed by permission of the Civil Engineering Department of the Massachusetts Institute of Technology, Boston, and Tangential Water Wheels, Abner Doble Company), contains a spindle-shaped concentric needle which may be advanced so as to reduce the area of the orifice or withdrawn so as to enlarge it, but the form of the annular passage-way is always such as to lead the water to converge along easy stream lines, until a circular jet of corresponding size is the result. In this way a range of 10 to 1 in the area of the jet may be attained, while the full head is always available. Very beautiful photographs are given showing the jets like clear glass rods instead of the familiar opaque and spray-clothed stream of water. Efficiencies from 96·4 to 99·3 for the energy of the jet are found, which correspond to 98·2 to 99·7 for the velocity.

IN vol. vi. of the *Transactions of the American Electrochemical Society*, which has just been published, Messrs. A. G. Betts and E. F. Kern publish a paper on the "lead voltameter." Two years ago Mr. Betts found that lead could be deposited in a non-crystalline and dense form from solutions of lead fluosilicate to which had been added a small quantity of gelatin. The Canadian Smelting Company now manufactures more than twenty tons a day of refined lead from solutions of lead silicofluoride. Until Mr. Betts discovered this process it had not been found possible to refine lead electrolytically. By using the above solution the authors have constructed a voltameter which is—according to their published results—more accurate than the copper coulombmeter, and does not fall far behind the silver instrument. A glass beaker is used as the electrolysing cell, and a kathode of thin lead sheet is hung between two anodes of the same metal. The calculated value of the electro-equivalent of lead is 103·46. In this instrument, in which the electrolyte was 8·5 per cent. $PbSiF_6$, 2·5 per cent. H_2SiF_6, and a small quantity of gelatin, the numbers found in six experiments ranged from 103·39 to 103·49. Among other papers of interest in the same journal we note the electrolysis of fused salts, by Dr. Lorenz; the electrical extraction of nitrogen from the air, by Mr. J. S. Edström; electrolysis and catalysis, by Dr. W. Ostwald.

THE latest number of the *Journal of the Russian Physical and Chemical Society* (1904, No. 9) contains the conclusion of an interesting study, by B. N. Menshútkin, on Lomonósoff as a natural philosopher and a chemist. Lomonósoff's services in the creation of the Russian literary language and poetry are well known; but the remarkable work of this eighteenth century natural philosopher, of whom his friend and correspondent, Euler, always spoke with great respect, had hitherto found no proper appreciation in his mother country. His ideas upon the structure of matter, the atomistic theory of chemical changes, the mechanical theory of heat, his kinetic theory of gases, his views on the liquid and the solid state, and his theory of atmospheric electricity, which, he said, is always present in the atmosphere, and originates from the changes in the thermal potential of ascending and descending air currents—all these theories being based upon molecular movements within the bodies—were expressed in terms almost identical with those which are used now. "It is," he wrote, "the inner, unseen motions of the corpuscles of which all bodies are composed which are the cause of every rise of temperature in a given body. These movements are rotatory. When a cold body is brought into contact with a hot one, the latter communicates to the former the movements of its particles, which therefore are slackened in the hot body, and accelerated in the cold one. The greater these rotatory movements, the greater the repulsive forces, and the weaker the connection between them."

DR. A. C. HADDON, F.R.S., is delivering a course of lectures on Saturdays at the Horniman Museum, Forest Hill, S.E., on "Magic and Primitive Religion."

THE first volume, that for 1904, has been received of a series of yearly publications to be issued by the Chemical Society under the title "Annual Reports on the Progress of Chemistry." The object of these reports is to present an epitome of the principal definite steps in advance which have been accomplished in the preceding year. The first volume contains articles on general and physical chemistry, by Prof. James Walker, F.R.S.; on inorganic chemistry, by Dr. P. P. Bedson; on the aliphatic division of organic chemistry, by Mr. H. J. H. Fenton, F.R.S.; on the aromatic and other cyclic divisions of organic chemistry, by Prof. J. B. Cohen; on stereochemistry, by Prof. W. J. Pope, F.R.S.; on analytical chemistry, by Mr. A. C. Chapman; on physiological chemistry, by Prof. W. D. Halliburton, F.R.S.; on agricultural chemistry and vegetable physiology, by Dr. J. A. Voelcker; on mineralogical chemistry, by Dr. A. Hutchison; and on radio-activity, by Mr. F. Soddy. These summaries of the chief advances in various branches of chemical science should prove of real benefit to students, teachers of chemistry, and professional chemists.

OUR ASTRONOMICAL COLUMN.

EPHEMERIS FOR COMET 1905 *a*.—A set of elements and a daily ephemeris for comet 1905 *a* are given in No. 4011 of the *Astronomische Nachrichten*. The ephemeris has been computed by Herr M. Ebell, and an extract is given below:—

Ephemeris 12h. (M.T. Berlin).

1905	α (true) h. m. s.	δ (true) ° ′	log r	log Δ	Brightness
May 12	9 45 27	+49 15·8	0·1066	9·9814	0·42
16	10 8 56	+49 44·2	0·1172	0·0002	0·36
20	10 31 29	+49 51·5	0·1281	0·0189	0·32
24	10 52 58	+49 40·1	0·1394	0·0375	0·28
28	11 13 11	+49 13·1	0·1508	0·0558	0·24
June 1	11 32 9	+48 32·8	0·1623	0·0740	0·21
5	11 49 51	+47 41·8	0·1739	0·0919	0·18

COMETS 1905 II (1904 *e*) AND 1904 I.—A daily ephemeris for comet 1904 *e*, computed by Dr Strömgren, is given in No. 4011 of the *Astronomische Nachrichten*. The comet is now very faint, and as seen by Dr. Palisa at the beginning of April it was 10″ in diameter, and had a fourteenth-magnitude nucleus. During the present month it will apparently travel through the constellation Lynx in a south-easterly direction towards Leo Minor.

A bi-daily ephemeris for comet 1904 I, computed by Herren Nijland and van d Bilt, is given in the same journal. This comet is also faint, being 0·052 as bright as when first discovered, its magnitude then being about 9·0. It is likewise situated in the constellation Lynx, and is apparently travelling in a S.S.E. direction towards Cancer, although at the beginning of September it will only be about 3° south of 35 Lyncis.

OBSERVATIONS OF JUPITER.—The results of their observations of Jupiter during the 1904–5 opposition are given by MM. Flammarion and Benoit in the May number of the *Bulletin de la Société astronomique de France*. Numerous points of change in the colours and forms of the various features are noted, and some of them are illustrated on the four drawings accompanying the article. Among the other conclusions derived from these observations the writers state the following:—(1) the estimations of the coloration of the equatorial bands do not confirm Mr. Stanley Williams's views as to periodical changes therein; (2) the appearance of the Great Red Spot has not changed since the previous opposition; (3) the large variation of the longitude of this feature between March and June, 1904, was probably due to the passage alongside it of the dark region of the tropical zone; (4) a clear spot situated in longitude 0° of system ii., and dividing the south equatorial band, appears to be a permanent feature which it will be well to observe assiduously. They further urge that careful attention should be paid at the end of this year to observations of the movements of the red spot, of the bright spots on the southern edge of south temperate band announced by Mr. Denning, and of the dark region situated in the south tropical zone.

THE ELECTRIC CHARGE OF THE SUN.—In No. 1, vol. x., of *Terrestrial Magnetism and Atmospheric Electricity* is reprinted the address "On the Electric Charge of the Sun" delivered by Prof. Svante Arrhenius before the International Electrical Congress held at St. Louis last September.

After briefly discussing the various theories regarding the nature of the sun's repulsive action, the author shows that the theory which explains the phenomena, by premising that the repulsion is due to radiation pressure acting on negatively charged particles, is in accordance with observational records. The particles having a specific weight of 1·0 and a radius of 0·08 μ are those which are repelled at the greatest speed, and would reach our atmosphere in about 45·9 hours, an interval of the same order as that obtained by Riccò for the time intervening between the probably correlated solar and terrestrial phenomena. These particles are negatively charged in accordance with Mr. C. T. R. Wilson's proof that such particles are more easily condensed on negative than on positive ions, the ionisation of the solar atmosphere resulting, as Lenard has shown, from the action of the sun's strong ultra-violet radiation. By a simple calculation Prof. Arrhenius shows that the remaining positive charge is balanced, and the balance maintained, by the attraction of negative electrons emitted by other celestial bodies which are negatively charged and lose their charge under the influence of their ultra-violet rays. All such rays coming within a mean distance of 0·063 light-years of the sun will be attracted thereto, and by this means the supply of negative electrons becomes just proportional to the defect thereof.

VARIABILITY OF MINOR PLANET (15), EUNOMIA.—*Circular* No. 94 of the Harvard College Observatory is devoted to an account of Prof. Wendell's observations of the minor planet Eunomia, from which he established a variation of magnitude of about 0·5. The observations were made with a photometer having achromatic prisms and attached to the 15-inch telescope. As the planet was near its stationary point it was compared with the same star, +13° 1875 (mag. 9·0), from March 15 to April 1, and the corrected differences varied from −0·77 to −1·11. The formula J.D. 2416920·116+0·1267 E. expresses the phase and period of the changes. The period is very similar to that found for minor planet (7), Iris, viz. 0·1295d., and in both cases it is still doubtful as to whether the period requires doubling or not.

FAINTNESS OF PLANETARY NEBULÆ.—Some interesting results of calculations appertaining to the luminosity of the surfaces of several planetary nebulæ, as compared with the surface luminosity of the sun or the moon, are given in a letter written by Mr. J. E. Gore to the current number of the *Observatory*.

Dealing with the nebula H, iv. 37, situated near to the pole of the ecliptic, he finds that the ratio of its surface luminosity is to that of the sun's as $1 : 43196{\cdot}7 \times 10^6$. The similar ratios for the nebulæ h 3365, Σ 5, and G.C. 7027 are $1 : 245{\cdot}3 \times 10^6$, $1 : 1095{\cdot}5 \times 10^6$, and $1 : 434 \times 10^6$ respectively; thus the brightest of them, *i.e.* h 3365, has a surface luminosity of only 1/400 that of the moon.

THE COWTHORPE OAK.

IN the *Transactions and Proceedings of the Botanical Society of Edinburgh* (vol. xxii., part iii., 1904, p. 396) we notice a very interesting article on the Cowthorpe Oak from the pen of Mr. John Clayton. This venerable tree, which stands near the church of Cowthorpe, a small village near Wetherby, is unique among oaks in that its girth is greater than that of any other known tree of its species. Recorded measurements taken about 1700 show that it had at that time a height of 80 feet with a girth of 78 feet on the ground. Since then various observers have recorded its dimensions and noted at the same time the gradual process of decay, damage by storm, and other points likely to be of interest. The latest measurements were taken by Mr. Clayton himself, and they show that the height is now reduced to 37 feet including dead wood, while the girth on the ground has diminished to 54 feet 3 inches. In 1893 a crop of acorns was produced, from one of which a seedling was reared, and is now planted near its parent as a memorial.

The tree stands in a warm, sheltered spot in a field which has a gentle slope to the river, and near enough to get a constant supply of water. The process of decay has been going on for the last 200 years. Between 1703 and 1722 much damage was done by various storms; nevertheless, new leaves are put forth annually. The acorns produced in 1893 were on long stalks—hence the species is *Quercus pedunculata*. As regards the age of this giant opinion seems to differ. The trunk, being now hollow, precludes all possibility of ever ascertaining the number of year-rings, and no trustworthy data are available before the year 1700—hence the author has been compelled to rely upon a comparison with the age of other trees. In a tree the duration of life may be taken as composed of

three periods, one of growth, one of maturity, and lastly one of decline and decay. Between the number of years in each period a certain ratio is found to exist, and, taking this as a basis, together with what is known of the tree since 1700, Mr. Clayton arrives at the conclusion that its age is not more than 500 years—certainly much nearer the mark than the age of 1600 years assigned to it by Prof. Burnett in 1842, who based his calculation on the theory of the elder De Candolle that a tree increases by one-twelfth of an inch in diameter annually, an altogether untrustworthy basis of calculation.

There is quite a number of other interesting historical trees dealt with in the article, for example, the Greendale Oak in Welbeck Park, which belongs to the Duke of Portland. Its height was recorded by John Evelyn in 1846 as 88 feet, while the altitude of the highest twig at the present day is only 54 feet. In 1724 a roadway was cut through the trunk, which girths 30 feet 1 inch at 4½ feet from the ground. The height of the archway was then 10 feet 2 inches, but recent measurements show that the highest point is now only 9 feet 3 inches, and the lowest 8 feet 6 inches. This shows conclusively that a subsidence of the trunk must have taken place within the last 200 years, and, by assuming that a similar sinking into the ground has occurred in the case of the Cowthorpe Oak, Mr. Clayton explains the apparent discrepancies between the earliest and latest recorded girth dimensions of the veteran. The trunk being somewhat tapering, the diameter naturally lessens as the sinking in proceeds. Mr. Clayton adds a note on the testimony of a Cowthorpe man named Oates, who said, "The tree has shrunk very much in my time, and in shrinking the tree has twisted—the Eastern branches towards the South."

Another notable tree as regards size and age is the Crowhurst Yew, which girths 34 feet 4 inches on the ground. It stands in the churchyard of that place. The church must be very old, as it contains monuments of Saxon and Norman workmanship. The author points out that the oldest trees are usually in close proximity to a sacred edifice, such as this yew and the Cowthorpe Oak, and the association no doubt affords them protection.

Another notable veteran is the great chestnut of Tortworth, Gloucester, which girths 49 feet 2 inches at 4 feet from the ground. It also stands about 100 yards from a very old and beautiful church.

As regards the longevity of trees, the theory was promulgated at the beginning of the nineteenth century by De Candolle that the duration of life in trees was practically unlimited, neglecting accidents due to unfavourable external conditions, such as the ravages of parasites, injuries from storms, lightning, and other causes. Passing in review the vegetable kingdom, we find there are some lowly organised plants, such as certain algæ and fungi, the whole life cycle of which may be completed within the short space of a few days, or even hours. Among the higher plants we have annuals and biennials the existence of which terminates with the production of seed. Then we have the agave and certain palms, the aërial portions of which may live from ten to forty years until the production of flower and fruit terminates their span of life, their place being taken by new aërial portions developed from lateral buds at the base of the plant. In the case of trees and woody shrubs, on the other hand, new growing points are formed annually, but this vegetative process does not end in the production of flower and fruit, so that, excluding accidents, there is no reason why that vegetative process should not be continued for an unlimited time.

Cowthorpe Oak, seen from North. The tree is supported by twenty-five props, disposed mostly on the South and East sides. There is a paling about 5 ft. high, which seems as if it had been put up from twenty to forty years ago.

The giant Wellingtonias of California are well known examples of the age and dimensions which trees may attain. A stem in the British Museum shows 1330 year-rings with a diameter of about 15 feet. On the other hand, certain Japanese dwarf trees are known to be of very great antiquity, although lacking the size of the Wellingtonias. At the same time, one must not lose sight of the fact that the living cells are continually being renewed, and that in a tree like the Cowthorpe Oak the living parts are at most but a few years old.

FISHERY INVESTIGATIONS IN THE NORWEGIAN FJORDS.[1]

DR. NORDGAARD has collected the results of investigations made in some of the fjords of northern Norway in the winters of 1899 and 1900, during the course of researches in the fishing waters of Lofoten, carried out at the expense of the Bergen Museum and the Norwegian Government. Two "expeditions" were made. The first, January to May, 1899, included the Vest Fjord and the sea beyond Lofoten, Vesteraalen, Sengen, and Finmarken, besides a large number of fjords, as the Kirk, the Øgs, the Kanstad, the Sag, and many others. The second, in the winter of 1900, was made so as to obtain material from the fishing banks which would compare with that of the previous year, and it included visits to the Morsdal, Salten, Skjerstad, and Folden fjords.

The hydrographical observations, which are numerous, have been made according to recognised standard methods, and are therefore comparable with observations made further out at sea, in the regions in which the full explanation of many of the facts brought to light here is doubtless to be found. The chief hydrographical result arrived at by Dr. Nordgaard is that the northern fjords can be divided into two groups, those in which the bottom temperature is 6° C. to 7° C., and salinity about 35 *pro mille*, and those in which the bottom temperature is below 6° C., and salinity less than 35 *pro mille*. As examples of the former, the Salten, Folden, Tys, Ofot, and Vest fjords are given, and as examples of the latter the Malang, Lyngen, Kvaenang, Porsanger, Tana, Varaanger, Skjerstad, Skjomen, Kanstad, Øgs, and Kirk fjords. It is suggested that while in some cases, as the Skjerstad fjord, the inflow of ocean water is cut off by a submarine ridge, the occurrence of the two typical groups may be accounted for by the distribution of rainfall. The heavy winter rainfall in western Norway affords a large supply of fresh water to the surface layers of the fjords, which accordingly remain specifically light, notwithstanding the fall of temperature. In northern Norway the rainfall is much less, hence the surface waters retain a high salinity, and as their temperature falls they sink to considerable depths.

Dr. Nordgaard also discusses at some length the varying influence of different amounts of rainfall on the currents within the fjords. Heavy rainfalls, which raise the surface level of the water, are for the most part the result of winds from the ocean, which produce a similar effect; it is difficult to separate the effects of the two causes, but a rainfall above the average is taken as a fairly certain index of abnormal strength in the oceanic streams.

In the "biological notes" which accompany the tables a number of points are brought out showing and defining the connection between fauna and hydrography. It is shown that whereas in the first or warm-water group of fjords the deep-water fauna is chiefly boreal, in the second group, where cold water of lower salinity makes its way downwards, the predominant forms are Arctic. The effect of the increased precision of modern methods of investigation in greatly reducing the number of so-called cosmopolitan species is also emphasised.

The section of this memoir which deals with fisheries is specially important and suggestive. In discussing the Lofoten fisheries, Dr. Nordgaard adopts the view that the currents in the Norwegian Sea are controlled by the winds, and that, as already explained, abnormal movements of the currents off-shore or on-shore can be associated with rainfall above or below the average. Again, he says, "It is clear that during the movements to or from the coast of the surface water, a compensating current must be set in motion in the deep water; it has long been a recognised phenomenon in the fjords, that the surface and under currents go in contrary directions." From an examination of the observations, Dr. Nordgaard concludes that herrings move coastwards specially in the surface layers, while the cod travels along in the deeper layers. It must therefore, he continues, "be supposed that as cod and herrings, to a certain extent, depend upon contrary current phases, a particularly good spring herring fishery would prevent a correspondingly good cod fishery in the same district; for a strong tendency of the upper layers towards the coast certainly takes herrings along in the current, but this at the same time causes a compensation current in the deep water, and this current hinders the cod in its passage to the spawning places."

The statistics of the yield of the cod and herring fisheries for some years are discussed and compared with corresponding values of rainfall, with results which appear to support the hypothesis brought forward. It would of course be easy to suggest difficulties, such as the extension of the current *régime* observed in fjords to areas which can hardly be regarded as such, and may therefore have a different system of movements. But as the whole question is at present under investigation on the large scale by the International Council, we content ourselves with an attempt to summarise Dr. Nordgaard's results, deferring fuller discussion of them until the more abundant data are available.

[1] Bergens Museum. "Hydrographical and Biological Investigations in Norwegian Fjords." By O. Nordgaard. "The Protist Plankton and the Diatoms in Bottom Samples." By E. Jørgensen. Pp 254; with 21 plates and 10 figures in the text. (Bergen: John Grieg, 1905.)

A NEW SLIDE RULE.

MESSRS. JOHN DAVIS AND SON, of Derby, the well known instrument makers, are bringing out a variation of the slide rule which is likely to increase its value for certain classes of calculation without interfering with the simplicity and convenience of the form with which we are all familiar. The lower groove on the outside of the rule, which ordinarily is only wide enough to hold the inturned edge of the cursor, is made wider, so as to take one of the tongues of a spare slide, and this slide is held in place when required by two light aluminium clips which grasp the ends of the rule and of the spare slide while leaving the usual slide free to move. An extra cursor is also provided which is long enough to grasp both the rule and the extra slide. By this means any rare or special scales upon the extra slide are for the time being equivalent to scales upon the rule, and these may be read against scales upon the other slide by means of the long cursor. If desired, the extra slide can take the place of the ordinary slide, or may be removed altogether when the rule, if provided with an ordinary cursor adapted to the altered lower groove, becomes an ordinary slide rule. In the example submitted, the extra slide carries what are called E and −E scales. The E scale is a log log scale, and is always being re-invented; it was called a P line or power line by Lieut. Thomson, who showed it at the Inventions Exhibition, and it was long before invented by Dr. Roget. This P or E line is very handy, for it at once enables the logarithm of any number on any scale, *i.e.* to any base, to be read according to its position against an ordinary A line, while fractional or high powers of numbers are read with equal facility. Compound interest, pressures and volumes of gases under isothermal or adiabatic conditions are readily evaluated with the aid of the E line read against an A line. If, however, a pair of E slides are used, one in the usual position and one attached below the rule by means of the clips, then against any value, say of v, on one, the cursor will show the value of v^γ on the other, γ having any desired value according to the relative position of the two slides.

The slide rules made by Messrs. Davis and Son are too well known for their accuracy and finish for it to be necessary to refer more to such points, but by some curious perversity or accident there is one little fault in the rule sent for examination which only needs to be pointed out to be put right. On the feather edge a scale of inches in 16ths is provided; on the lower face outside the rule there is no scale at all, while inside, to be used like a hat measure, there is a scale of millimetres beginning at 550. If, therefore, the rule is required for the prosaic but very useful purpose of measuring a length, this can only be measured in inches if it is 20 inches or less, or in millimetres if it lies between 550 and 1040 millimetres. If,

therefore, the bald outside edge were divided in millimetres, the whole range would be available for metric measurement, and if the lower half of the space at the back of the slide now empty were divided in inches, hat measurements from 20 to 41 inches would complete the range for the English scale. C. V. B.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Mr. Frederick Wilkin, of Lower Consley Wood, Wadhurst, Sussex, proposes to found a studentship in memory of his son, Mr. Anthony Wilkin, late of King's College, and for this purpose he proposes to make over to the university the tithe rent charge on Wadhurst Parish. This benefaction is for the furtherance of ethnological and archæological research, and the holder is to be termed "The Anthony Wilkin Student." It is proposed that the student shall be selected by the board of anthropological studies; the income is estimated at about 40*l*. a year, and the board suggests that this should be accumulated for periods of five years in order that a substantial sum of about 200*l*. may be available for the selected candidate. The first studentship will be offered in 1910.

Mr. W. W. Watts, of Sidney Sussex College, Mr. H. Y. Oldham, of King's College, Mr. A. R. Hinks, of Trinity College, and Mr. G. G. Chisholm have been appointed examiners for part ii. of the examination for the diploma in geography.

A combined examination of non-resident candidates for open scholarships, exhibitions, &c., will be held at Trinity College, Clare College, Trinity Hall, Peterhouse, and Sidney Sussex College, Cambridge, beginning on Tuesday, December 5. Forms of application for admission to the examination may be obtained from any of the tutors of Trinity College, the senior tutor of Clare College, the tutor of Trinity Hall, the senior tutor of Peterhouse, or the master of Sidney Sussex College, to one of whom the form of application (when filled up), together with certificates of birth and of moral character, should be sent. Entries should be made not later than November 23.

A teaching observatory will, it is reported by *Science*, be established by the Ontario Government at the University of Toronto. Dr. C. A. Chant expects to visit the observatories of the United States to study their plans and methods.

A conference of scientific students was held at Colorado College, Colorado Springs, on April 28 and 29, and representatives of leading universities and colleges were present. A number of papers upon subjects relating to the scientific problems of the Rocky Mountain country were read. A similar conference, held a year ago at the same institution, was of such importance that it led to this second series of meetings.

With the view of making the municipal museum a centre of education in the broad principles of natural science, the Hull authorities have arranged with the curator, Mr. T. Sheppard, for the delivery by him of simple lectures to school children on geology, zoology, and anthropology. The lectures are given in the mornings by arrangement. Permission for pupils to visit the museum must be obtained from the clerk of the education committee. Each lecture lasts about half an hour, and is illustrated by objects from the cases. The remainder of the morning is occupied in examining the specimens, taking notes, and making sketches.

Mr. A. C. Benson contributes to the *National Review* an important article on an Eton education. Mr. Benson, though a classicist, is by no means satisfied with the existing state of educational matters at Eton. Describing the average boy who leaves Eton, Mr. Benson says:—"The basis of his education has been, as a rule, the classical basis; that is to say, the greater part of his working hours have been devoted to Latin and Greek. A small percentage of fair classical scholars and a still smaller sprinkling of distinguished classicists is the result. But the average boy leaves Eton with no mastery of either of these languages. He cannot, as a rule, construe at sight an easy passage in either, or turn a piece of English into either language without a large crop of mistakes." In another place Mr. Benson states that the boy "never reaches the stage at which classics become literature." He urges that for the large class of boys who are not intended for the university, the strictly classical programme might be with advantage modified. Mr. Benson believes that a boy who left school with a thorough knowledge of French, "who knew the elements of science, so as to be able to understand something of what was going on in the world around him, in heaven and earth and sea, in field and wood," who knew arithmetic and had a reasonable knowledge of geography and history, would leave school a fairly educated man. Mr. Benson would have a very simple core of education on the lines just indicated, and then any evidence of special capacity, linguistic, mathematical, scientific, or historical, should be carefully observed, and at a certain age a boy's studies should converge more closely upon a special subject, care being taken at the same time that the general education should not be neglected.

A valuable address was delivered by Prof. A. Pedler, F.R.S., Vice-chancellor of the University of Calcutta, and Director of Public Instruction with the Government of Bengal, at the recent convocation of the Senate of the university for conferring degrees. During the course of his remarks, Prof. Pedler said that fifty years ago university education in Bengal had no existence, the doors of western learning had not been opened, and the knowledge of western science was absolutely beyond the reach of anyone in the country. During the last half-century the possibilities of obtaining western knowledge and western culture, and the facilities for higher education, have been rapidly developed, until a whole network of educational institutions has been spread over Bengal. Inquiring as to whether the form of education being given to the people is affecting them in the most satisfactory way, Prof. Pedler came to the conclusion that it is not. The arrangements, he said, are wanting in concentration of effort, in thoroughness of method, and in the intelligent appreciation of means to ends. After instituting a comparison between what has been accomplished in Japan and in Bengal, he came to the conclusion that the secret of the brilliant success of university education in Japan is to be found in the observance of certain cardinal principles, viz. patience in obtaining results; thoroughness in work; concentration of university work in a few really well equipped and strongly staffed colleges, each institution being devoted to a special section of learning, which is taught thoroughly; adaptation of the courses to the practical wants of life and of modern civilisation, as exemplified by the large proportion of graduates who elect the practical rather than literary courses of study; originality as shown by the large number of young men who undertake research work, and also shown by the large number of original contributions in science. In the future, Prof. Pedler remarked, it will be necessary in Bengal to adopt all these principles and to adhere to them with uncompromising tenacity, if university work is to be placed on a really satisfactory footing. The principles could also be applied with profit to a large part of the work of our own educational institutions.

SOCIETIES AND ACADEMIES.

London.

Geological Society, April 19.—Mr. H. B. Woodward, F.R.S., vice-president, in the chair.—The Blea Wyke beds and the Dogger in north-east Yorkshire: R. H. **Rastall.** The author describes the type-section at Blea Wyke in detail, dividing the rocks into the following divisions, enumerated in descending order:—(5) Dogger; (4) yellow beds; (3) Serpula beds; (2) Lingula beds; (1) Striatulus shales. Descriptions and fossil lists from these divisions are given, and the succession is compared with others.—Notes on the geological aspect of some of the north-eastern territories of the Congo Free State: G. F. J. **Preumont,** with petrological notes by J. A. **Howe.** This paper is a brief sketch of the geological structure of the northern part of the Congo State, from Buta on the River Rubi and Bima

on the Uelle in the west, to Lado and Dufile on the Nile. In the whole of this region, the only post-Primary rocks met with, other than those of comparatively modern alluvial origin, were chocolate-coloured shales (Buta Shales) and sandstone, and an Oolitic limestone, on the extreme west. From the Lipodongu Falls on the Rubi, and thence through Poko to Rungu, on the Bomokandi River, none but granitic rocks (gneisses) were observed. Along the Uelle, from Bima to Bomokandi, the same rocks were seen. In the centre of the region mica-schists, quartzites, and similar metamorphic rocks replace the granite wholly or in part. A noticeable feature here is the presence of a range of isolated hills, composed almost completely of great beds of magnetite and hæmatite occurring in the schistose series. In the south-eastern portion of the region visited, between the Uelle-Kimbali and Bomokandi rivers, a great plutonic massif is laid bare in the mountainous district of Arebi. The plutonic massif itself contains microclinic gneiss, and abundant diabasic rocks, and the same rocks in all stages of dynamo-metamorphism. On the boundary between the Congo State and the Bahr-el-Ghazal, several hills made up of rocks of coarse gneissose and schistose character are described; some of these rocks are rich in tourmaline, kyanite, and garnet in large crystals. From the region of the Enclave de Lado and the western side of the Nile between Lado and Dufile, mica-schists, quartzites, and microcline-gneisses are described. The alluvium of a large part of the Uelle is covered, on the higher ground, by a deposit of limonitic conglomerate; in places this may be due to the decomposition *in situ* of the alluvium, but in the neighbourhood of the iron-mountains a sort of passage may be seen between a conglomerate of fresh iron-ores and the more general type of limonitic conglomerate (laterite?).

Paris.

Academy of Sciences, May 1.—M. Troost in the chair.—New researches on chemical combination: M. **Berthelot**. Various substances were sealed up in fused quartz tubes, heated for one hour at 1300° C. in an electric furnace, and suddenly cooled by dropping into water. Nitrogen and hydrogen gave no trace of ammonia; ammonia was completely split up into its constituents, and the stability was not increased by the presence of hydrochloric acid. The latter gas, heated alone, was not decomposed, and hydrogen sulphide behaved similarly if the cooling was slow, but showed evidence of dissociation into hydrogen and sulphur with instantaneous cooling.—On the permeability of tubes of fused silica: M. **Berthelot**. At the ordinary temperature, no hydrogen will pass through the walls of a fused quartz tube, even into a barometric vacuum, and even at 600° to 800° no appreciable amount passes through. At 1300° C., on the other hand, the amount transpired is considerable. Neither hydrochloric acid nor carbon dioxide get through at 1300° C.; the transpiration of nitrogen is not sensible at 600° C., very slight at 1000° C., becoming marked at 1300° C. to 1400° C. Some preliminary experiments with glass at lower temperatures appear to show similar effects, and these observations are being continued.—The action of mercuric iodide on sulphuric acid and on the sulphates of mercury: Alfred **Ditte**.—On the earthquake of April 29: M. **Mascart**. The seismograph at Bagnères-de-Bigorre showed horizontal vibrations at 2h. 1m. 20s., whilst the same oscillation was indicated at Grenoble at 1h. 59m. 15s., a difference of time corresponding to the rate of transmission through the ground.—On the triboluminescence of arsenious acid: M. **Guinchant**. The light given off by arsenious acid is due to the breaking and transformation of the crystals after their formation. The radiations are actinic, and are without any effect on the electroscope. Similar phenomena taking place during the reduction of hypochlorites and hypobromites are described, the effects in this case being attributed to the production and decomposition of haloid compounds of nitrogen.—On the physical impossibility of putting in evidence the motion of translation of the earth: P. **Langevin**. In a discussion of an experiment by Trouton and Noble it is proved that it ought to give a negative result for all orders of approximation and whatever system of suspension be employed for the condenser.—On the heat of vaporisation of liquefied gases: E. **Mathias**.—Heat in the displacement of a capillary system: M. **Ponsot**.—On the difference in temperature of bodies in contact: E. **Rogovski**. Fine wires of different diameters were heated by an electric current, and cooled by water flowing at known rates. The temperature of the wire was measured by means of its electrical resistance, and the difference of temperature between the wire and the cooling water determined as a function of the rate of flow of the water and of the diameter of the wire.—The preparation of anhydrous chlorides of the metals of the rare earths: Camille **Matignon**. The solid material obtained by the evaporation of the solution of the oxide in hydrochloric acid is heated in a current of chlorine and hydrochloric acid gas charged with the vapours of chloride of sulphur. It is possible to obtain in this way very rapidly either large or small quantities of anhydrous chlorides. Particulars are given with analyses showing the purity of the products, of the chlorides of lanthanum, neodidymium, praseodidymium, samarium, and yttrium.—On cæsium amide: E. **Rengade**. The amide is prepared by the action of dry ammonia upon the fused metal at 120° C., the purity of the product being fixed by the determination of the amount of hydrogen evolved. The amide dissolves readily in liquid ammonia, and the solution absorbs oxygen at −60° C. giving a precipitate, the hydroxide and nitrite of cæsium being formed, together with ammonia.—On a new reagent for potassium: Eugenio Pinerua **Alvarez**. The reagent proposed is a 5 per cent. solution of sodium amido-naphthol sulphonate.—On the conditions of development of the mycelium of Morchella: G. **Fron**. The mycelium of this edible mushroom requires for its strong growth plenty of hydrocarbon food, inulin and starch being especially favourable; the mineral food is of less importance.—Calcium nitrate in agriculture: E. S. **Bellenoux**. The author proposes to replace nitrate of soda by the nitrate of calcium, and gives results of comparative trials of the two showing the superiority of the latter as a manure.—The variation of the osmotic pressure in muscle caused by contraction: Stéphane **Leduc**. It is shown experimentally that an elevation of the osmotic pressure in a muscle is a consequence of contraction, the rise of the pressure being more marked as the stimulations are more prolonged.—The variations undergone by glucose, glycogen, fat, and soluble albumens in the course of the metamorphoses in the silkworm: C. **Vaney** and F. **Maignon**.—On a combination of methæmoglobin containing fluorine: H. **Ville** and E. **Derrien**. In a previous paper the authors have shown that the addition of fluorine compounds to a solution of methæmoglobin causes a marked change in the absorption spectrum, and they were thus led to the conclusion that a definite compound might possibly be produced. This compound has been isolated in the crystalline form, details of its preparation and properties being given in the present note.—Philocatalase and anticatalase in animal tissues: F. **Battelli** and Mlle. L. **Stern**.—On the action of formic acid in nervous diseases accompanied with trembling: E. **Clément**. The use of formic acid has been attended with great success in certain cases.—The volcanic regions traversed by the Sahara expedition: F. **Foureau** and Louis **Gentil**.

New South Wales.

Linnean Society, March 29.—Mr. T. Steel, president, in the chair.—The botany of north-western New South Wales: F. **Turner**. The characteristics of the indigenous vegetation and the exotic weeds of the country lying between the New South Wales-Queensland border and 33° S. lat., and 147° and 151° 20′ E. long., are discussed. The census of the phanerogams and vascular cryptogams given comprises a total of 452 genera and 1137 species.—Contribution to our knowledge of the physiology of the pancreas: H. G. **Chapman**. The conclusions arrived at in this paper, which is a preliminary communication, may be summarised as follows:—(1) secretins from the echidna, wallaby, Australian water-tortoise, and ibis are active upon the dog in causing a flow of pancreatic juice; (2) secretin does not appear to cause pancreatic secretion in the echidna; (3) the flow of pancreatic juice produced by pilocarpine is inhibited by atropine, while the flow produced by secretin is not so

inhibited; (4) stimulation of the vagus nerve does not inhibit the secretion due to secretin; (5) the pressure under which the fluid is secreted in the pancreatic duct is equivalent to 9 inches of the juice; (6) pancreatic juice may be activated by leucocytes so that it acts upon proteids.

DIARY OF SOCIETIES.

THURSDAY, MAY 11.

ROYAL SOCIETY, at 4, Election of Fellows.—At 4.30, On the Resemblances existing between the "Plimmer's Bodies" of Malignant Growths and certain Normal Constituents of Reproductive Cells of Animals: Prof. J. B. Farmer, F.R.S., J. E. S. Moore, and C. E. Walker.—The Effect of Plant Growth and of Manures upon the Soil: the retention of Bases by the Soil: A. D. Hall and Dr. N. H. J. Miller.—A Study of the Process of Nitrification with Reference to the Purification of Sewage: Miss H. Chick.—Pathological Report on the Histology of Sleeping Sickness and Trypanosomiasis; with a Comparison of the Changes found in Animals infected with *T. gambiense* and other Trypanosomata: Dr. A. Breinl.—(1) The Experimental Treatment of Trypanosomiasis in Animals; (2) Remarks on Mr. Plimmer's Note on the Effects produced in Rats by the Trypanosomata of Gambian Fever and Sleeping Sickness: Dr. H. Wolferstan Thomas.

ROYAL INSTITUTION, at 5.—Flame: Sir James Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Manufactures of Greater Britain. III. India: H. J. Tozer.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telephone Traffic: H. L. Webb.

SOCIOLOGICAL SOCIETY, at 8.15.—Some Guiding Principles in the Philosophy of History: Dr. J. H. Bridges.

MATHEMATICAL SOCIETY, at 5.30.—On the Intersections of two Conic Sections: J. A. H. Johnston.—On a System of Conics yielding Operators which Annihilate a Cubic and its Bearing on the Reduction of the Cubic to the Sum of four Cubes: H. G. Dawson.—High Pellian Factorisations: Lt.-Col. A. Cunningham.

FRIDAY, MAY 12.

ROYAL INSTITUTION, at 9.—The Pressure due to Radiation: Prof. E. F. Nichols.

PHYSICAL SOCIETY, at 8.—A Simple Method of Determining the Radiation Constant; suitable for a Laboratory Experiment: Dr. A. D. Denning.—A Bolometer for the Absolute Measurement of Radiation: Prof. H. L. Callendar, F.R.S.—The Resistance of a Conductor the Measure of the Current flowing through it: W. A. Price.

MALACOLOGICAL SOCIETY, at 8.—Note on *Helix pellita*, Fér., and other Shells from the Pleistocene Cave-deposits of East Crete: Rev. R. Ashington Bullen.—Notes on Recent Spanish Shells from Granada and Carmona: Rev. R. Ashington Bullen.—Description of a new Species of Vitrea from Greece: E. A. Smith.—Descriptions of new Forms of Marginellidæ and Pleurotomidæ: E. R. Sykes.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Discussion of the Observations of the Satellite of Neptune made at the Royal Observatory, Greenwich, in the years 1902–3–4: F. W. Dyson and D. J. R. Edney.—Further Note on the Density and Prolateness of Close Binary Stars: A. W. Roberts.—On Hansen's Coefficients for the Inequalities in the Moon's Longitude: E. Nevill.—A Supposed Instance of Sudden Change on Jupiter: Major P. B. Molesworth.—Optical Distortion of the Object Glass of the Astrographic Telescope, deduced from Measures of the Eros Photographs, Communicated by the Astronomer Royal: Royal Observatory, Greenwich.—*Promised Papers*: On the Formula for Connecting Photographic Diameters with Stellar Magnitudes: H. H. Turner.—The Determination of Stellar Proper Motions without Reference to Meridian Observations: A. R. Hinks.—Notes on the Use of Thorp Gratings for Eclipse Work: Dr. W. J. S. Lockyer.

SATURDAY, MAY 13.

ROYAL INSTITUTION, at 3.—Moulds and Mouldiness: Prof. Marshall Ward, F.R.S.

MONDAY, MAY 15.

SOCIETY OF ARTS, at 8.—The Uses of Electricity in Mines: H. W. Ravenshaw.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration and Survey in Central Tibet and to the Sources of the Brahmaputra: Captain C. H. D. Ryder.

VICTORIA INSTITUTE, at 4.30.—The Messiah of Quadian: The Rev. Dr. Griswold.

TUESDAY, MAY 16.

ROYAL INSTITUTION, at 5.—The Study of Extinct Animals: Prof. L. C. Miall, F.R.S.

ROYAL STATISTICAL SOCIETY, at 5.

ZOOLOGICAL SOCIETY, at 8.30.—A Contribution to the Knowledge of the Encephalic Arterial System in Sauropsida: F. E. Beddard.—On Stridulating Halyinæ with Descriptions of New Genera and Species: Dr. E. Bergroth.—On the Classification of the Anthropoid Apes as Proposed by the Hon. Walter Rothschild: Sir Harry Johnston.

SOCIETY OF ARTS, at 8.—Excavation of the Oldest Temple at Thebes: H. R. Hall.

WEDNESDAY, MAY 17.

SOCIETY OF ARTS, at 8.—The Use of Wood Pulp for Paper Making: S. Charles Phillips.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Movements of Diatoms and other Microscopic Plants: D. D. Jackson.—Exhibition of Slides of the Oribatidæ.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—Measurement of Evaporation: R. Strachan.—Logarithmic Slide-Rule for reducing Readings of the Barometer to Sea-level: Dr. J. Ball.

CHEMICAL SOCIETY, at 5.30.—The Chlorination of Methyl Derivatives of Pyridine. Part I. 2-Methyl Pyridine: W. J. Sell.—The Absorption Spectra of Uric Acid, Murexide and the Ureides in Relation to Colour and to their Chemical Structure: W. N. Hartley.—Further Studies on Dihydroxymaleic Acid: H. J. H. Fenton.—The Thermal Decomposition of Formaldehyde and Acetaldehyde: W. A. Bone and H. L. Smith.—The Synthesis of Formaldehyde: D. L. Chapman and A. Holt, Jun.—The Influence of Light on Diazo-reactions. Preliminary Notice: K. J. P. Orton, J. E. Coates, and (in part) F. Burdett.

THURSDAY, MAY 18.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On Lesage's Theory of Gravitation and the Repulsion of Light: Prof. G. H. Darwin, F.R.S. The Atomic Weight of Chlorine; an Attempt to Determine the Equivalent of Chlorine by burning with Hydrogen: Prof. H. B. Dixon, F.R.S., and E. C. Edgar.—The Flow of the River Thames in Relation to British Pressure and Rainfall: Sir Norman Lockyer, K.C.B., F.R.S., and Dr. W. J. S Lockyer.—Thorianite, a New Mineral, from Ceylon: Prof W. R. Dunstan, F.R.S., and G. S. Blake.—The Elastic Properties of Steel at High Temperatures: Prof. B. Hopkinson and F. Rogers.—Modified Apparatus for the Measurement of Colour, and its Application to the Determination of the Colour Sensations: Sir William de W. Abney, K.C.B., F.R.S.—Further Observations on the Germination of the Seed of the Castor Oil Plant (*Ricinus communis*): Prof. J. Reynolds Green, F.R.S., and H. Jackson.—On the Efferent Relationship of the Optic Thalamus and Deiter's Nucleus to the Spinal Cord, with Special Reference to the Cerebellar Influx Theory (Hughlings Jackson) and the Genesis of Decerebrate Rigidity (Sherrington): Dr. F. H. Thiele.—On Reciprocal Innervation of Antagonistic Muscles. Eighth Note: Prof. C. S. Sherrington, F.R.S.—The Structure and Function of Nerve Fibres: Prof. J. S. Macdonald.—On the Occurrence of Anopheles (Myzomyia) Listoni in Calcutta: Major A. Alcock, C.I.E., F.R.S., and Major J. R. Adie.

ROYAL INSTITUTION, at 5.—Flame: Sir James Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—Plague in India: Dr. C. Creighton.

FARADAY SOCIETY, at 8.—An Application to Electrolytes of the Hydrate Theory of Solutions: T. M. Lowry.

FRIDAY, MAY 19.

ROYAL INSTITUTION, at 9.—The Native Races of the British East Africa Protectorate: Sir Charles Eliot, K.C.M.G.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

SATURDAY, MAY 20.

ROYAL INSTITUTION, at 3.—The Evolution of the Kingship in Early Society: Dr. J. G. Frazer.

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THURSDAY, MAY 18, 1905.

THE BIRDS OF CENTRAL AMERICA.

Biologia Centrali-Americana. Aves. By Osbert Salvin, M.A., F.R.S., and Frederick Ducane Godman, D.C.L., F.R.S. 4 vols. (London: 1879–1904.)

CONGRATULATIONS to the surviving author of these volumes must be mingled with deep condolence that his long-tried coadjutor and comrade should not have been spared to complete this portion of the great work in which they were jointly engaged, and to supply that summary of its contents which he, perhaps, alone could have written. But acutely as the loss of Mr. Salvin is to be lamented, if on no other account than this, no less real is the gratification with which the bringing to an end of a task that has lasted for a quarter of century is to be regarded, and the relief to Mr. Godman's mind at the accomplishment of another portion of his gigantic design must be enormous. It is getting on for twenty years since the volume treating of the mammals of Central America was reviewed in these pages by the late Sir William Flower (NATURE, xxxiv., p. 615, October 28, 1886), and that portion also suffered by the untimely death of its author, Mr. Edward R. Alston, so that instead of the comprehensive view of the mammalian fauna of the country which he had intended to appear in the introduction to the volume, we had merely a series of tables of distribution which he had prepared to found that view upon, and these tables Mr. Sclater, who prefixed a few prefatory sentences, left to speak for themselves. Speak for themselves they did, but they needed an interpreter, since they were drawn up for the most part on geographical lines—or, to be more accurate, from a politico-geographical base, the geographical element preponderating.

The tables given in the first of the volumes treating of birds, and now before us (being almost identical in form with those contained in the "Introduction"[1] to the first volume on Lepidoptera), do not differ very greatly in character, though herein the political divisions of the country are given in greater detail, so as to be more important than the geographical. Now each of these methods unquestionably has its advantages—mostly of a practical kind. If we want to see or obtain examples of any particular kind of animal, it is convenient to know where it may be found. But it can hardly be doubted that, had Mr. Salvin lived, he, with his experience of the country and its ornithology, would scarcely have been content without trying if it were not possible to treat the distribution of the species, genera, and families as well from a physical point of view. That he was fully aware of the importance of taking that aspect of the question is shown by the pithy remarks on the subject in an article published by Mr. Godman and himself in *The Ibis* for 1889 (p. 242)—several years, be it observed, after the appearance of Mr. Alston's tables. The labour, no doubt, would have been immense, and only to be performed by one possessed of such knowledge, alike minute and wide, as Mr. Salvin had; but assuredly he was convinced that it can never be too strongly impressed upon all students of topographical distribution that the key to the subject lies in the physical features of the country, especially of a tropical country of such varied character as Central America. Even an indication of the rough division into the three well known zones—the *tierra caliente*, the *tierra templada*, and the *tierra fria* would be better than nothing, though in a country extending over so many degrees of latitude and of such diverse heights, what is the *tierra templada* of one district becomes the *tierra fria* of another.

At the same time, it must be admitted that more than this is required. Comparative altitudes and the extent of forest-growths may explain some things, but they will not account in all cases for the limits of the area to which a certain form, say Pharomacrus or Oreophasis, may be confined. But if boundaries are not to be accounted for by physical characters, assuredly they can be still less rationally explained on political or geographical grounds. Considerations of this kind seem to point to the futility of attempting to lay down any boundaries at all, unless those that are physical can be traced, and of course the difficulty of tracing them is sometimes very great. To take a familiar instance here at home. Who can define on physical grounds, or correlate with them, the distribution of the nightingale in England and Wales? Hence it may be fairly urged that it would be far better for zoologists generally to leave off speaking of areas, regions, subregions, provinces, and the like, and to regard the animal population of a country solely from the faunal point of view.

Central America would seem especially to lead to some such conclusion as this. It can hardly be doubted that the existing fauna of America—North and South—is the result of at least three perfectly distinct faunas, which have originated in, or been derived from, as many different tracts, and probably at as many different epochs. In Central America all three meet, though one is overwhelmingly out of proportion to the other two. This is practically identical with the fauna of by far the greater part of South America as distinguished from that of Patagonia, which seems to have had a very different origin and history, while the former is equally distinct from that which prevails now over the greater part of North America—this last being, as Prof. Huxley long ago intimated (*Proc. Zool. Soc.*, 1868, p. 314), much more closely allied to the Palæarctic fauna, if, indeed, he might have added, it be not substantially of Palæarctic extraction. Then again, while comparatively few of the members of the fauna now dominant in Central and the greater part of South America have penetrated to the area at present occupied by the apparently much more ancient Pata-

[1] That "Introduction" also contains a succinct description, excellent so far as it goes, by Mr. Godman, of the natural features of each political district of Central America, which is taken to include the whole of Mexico from the Rio Grande and the Rio Gila, but excluding Lower California, and thence to the Isthmus of Darien in the now independent State of Panama. The subject has been much more elaborately treated, though of course with especial reference to the flora of the country, by Mr. Hemsley in his admirable "Appendix" to the fourth volume of the "Botany" of the whole work (pp. 138–170).

gonian fauna in the extreme south, a considerable portion have invaded North America—possibly re-occupying the home whence they had been driven during some glacial period, but certainly to an extent that sensibly affects the existing fauna. In the same way certain characteristic forms of the Patagonian fauna, diminishing in number as the distance from their modern focus increases, occur throughout the whole length of South America, generally clinging to the slopes of the Andes, and a few reach the highlands of Central America—Scytalopus, for instance, the sole example of that most characteristic Patagonian family, Pteroptochidæ, which has made its way into Costa Rica.

Further into detail it would be impossible here to go, for it would need the exhibition of long lists and tables showing the distribution of various groups or forms to make clear the truth of the statements just enunciated, to which, no doubt, some will demur; but it may be mentioned that their truth does not rest alone on the evidence afforded by birds, for a close examination of the other classes of vertebrates will be found to corroborate the same position, and it may be left for time to show whether the opinions here expressed are not generally accepted as true. Briefly recapitulated, they are that the whole of America is now occupied by three faunas. The very ancient and, it may be added, morphologically low Patagonian in the south; that of a somewhat higher morphological rank which peoples the greater part of South America, all of Central America, and permeates almost to the middle of North America, until it is outnumbered by still higher forms derived from a Palæarctic stock; but to lay down any boundaries, even physical boundaries, for these distinct faunas is impossible, and though we may call the first and last "Patagonian" and "Nearctic" respectively, it is not easy to find a good title for the second, unless we were to apply to it Mr. Sclater's original name, "Neotropical," restricting that in the southern direction and extending it in the northern. It has been called "Columbian" by one writer, and if that epithet had not been used before in a much more limited sense by another writer the name would not be inappropriate, for Colombia may be regarded as its modern focus, but doubtless it anciently extended much further to the northwards, and by it in remote times the Sandwich Islands were most likely colonised.

If these remarks be deemed too critical, it must be understood that they are not intended to be generally opposed to the views of Mr. Godman. Writing of the butterflies in the "Introduction" before referred to, he stated expressly that the fauna of Central America "is mainly a northern extension of that of tropical South America," with a considerable number of Nearctic forms "coming down the central plateau a certain distance into Mexico, and some even into Guatemala." This is not only equally true of the birds, but the southern extension of their northern forms reaches even further. The real question is, what value is to be attached to these northern forms? A very slight examination will show that nearly all belong to families that are essentially Neotropical. It has been pointed out before now that the so-called Nearctic "Region" has not more than one peculiar family of birds (Chamæidæ), and that a very doubtful one. All the other families of land-birds are either Neotropical or Palæarctic, so that in one sense it may be said that no distinct, or peculiar, Nearctic fauna exists, the bird-population of North America having (with that one doubtful exception) wholly Palæarctic or Neotropical affinities, and those often of the very closest nature. No stronger corroboration of the views of Prof. Huxley, Prof. Heilprin, and others who have advocated the abolition of the Nearctic "Region" can be adduced than is furnished by Mr. Godman's tables, and when we speak of a Nearctic fauna, such as exists now, we mean a mixed multitude of either Neotropical or Palæarctic extraction, or having a common origin with one or the other of those faunas.

But it will not do here to follow further this interesting theme, important as it is in the light that it sheds on the history of the modern inhabitants of the earth. Something must be said before we leave these volumes of the way in which they are presented to the public. Considering that upwards of 1400 species of birds had to be included, the amount of space available for the treatment of each must necessarily be small. But here a most rigid and commendable economy has been practised. No space is needlessly taken up by considerations of taxonomy, nomenclature, or such like ancillary subjects on which so many faunal writers deem it expedient to dilate, though the first is only wanted in a general treatise and the second is regarded by the wise as a snare to be avoided by all who have no time to waste over frivolities. By many of the younger zoologists of the present day the principle of nomenclature followed by the authors will be set down as old-fashioned, but considering the weight of the authorities cited, and their number, the application of the principle is abundantly justified, though exception to some of the results may here and there be reasonably taken, and sufficient synonymy is given as to preclude any possible confusion. In like manner there is no attempt to invent a new classification, for which, in the present state of flux, all should be thankful. That which has been in use by taxonomers for some thirty years in respect to American, or at least South American, birds is adopted. Be its faults what they may, it is well understood by the great majority of those who have been most interested in the subject during that period. The localities whence each species has been recorded are duly noted in the account of it, and thus the details of its range may in most cases be very fairly traced, while reference is systematically made to the authority responsible for the statement, and this, needless to say, is a very important matter. Furthermore, the distinguishing characters of both genera and species are presented with the skill that comes only from intimate knowledge of the respective forms and careful comparison of them with their allies, a feature that is often absent in modern ornithological works, and in one of this magnitude is especially to be commended. The species

figured, one hundred and fifty in number, seem to have been well selected, and the plates in which they are represented by Mr. Keulemans are in the style which has won him so much reputation as an ornithological artist. But all these merits pale before the admiration which the bold conception and patient execution of this grand undertaking excites. There is no English work on natural history comparable in these respects with the "Biologia Centrali-Americana," and the only foreign one which it calls to remembrance is the marvellous "Madagascar" of the late M. Grandidier. The debt due by naturalists of all branches and of all countries to the enterprise, the zeal, and the perseverance of both Messrs. Salvin and Godman, and to the munificence of the latter, for without that all the rest would have availed little or nothing, is one that can never be repaid. A. N.

VECTOR MECHANICS.

Die Grundlagen der Bewegungslehre von einem modernen Standpunkte aus. By Dr. G. Jaumann. Pp. vi+422. (Leipzig: J. A. Barth, 1905.)

THIS work is intended as a systematic general introduction to mechanics; as in the recent English exposition of Webster, the whole field of solid and deformable bodies is considered, so that the book has a wide range—a feature which must necessarily be purchased to some extent at the expense of depth.

Dr. Jaumann, following a method which now enjoys some popularity on the Continent, treats the subject by vectorial methods throughout. The first chapter introduces the ideas of velocity and acceleration, and with them the ideas of the vector and the scalar and vector products of two vectors. This is very natural and well written; it is, however, followed by the introduction of dyads, which was scarcely to be expected at this early stage of the work; and when the author, as is the habit of those writers who apply vectors, takes the liberty of making some additions to the vector calculus itself, and plunges us forthwith into an able but somewhat difficult discussion of "rotary" dyads, we are thrown into doubt as to the class of readers for whom the book is designed.

After this we come back to the ideas of partial and absolute acceleration, illustrated by astronomical considerations, and to the conception of gravitation, with an account of Kepler's laws. This closes the first section of the book, which, though interesting, leaves an unsatisfied and helpless feeling behind it, for the student (if the book is written for students) has not learnt how to find for himself the path of a point in a given field of acceleration, which is surely the main problem of this part of the subject. Thus, although Foucault's pendulum is described, the theory of it—which would make no greater demand on the mathematical capacity of the reader than the rotary dyads require—is not worked out.

The author now introduces the idea of mass, which is defined (as in most good modern works) by means of what used to be called the principle of action and reaction; in other words, the ratio of the masses of two particles is defined as the ratio of the accelerations which they induce in each other when moving under each other's influence, and the idea of "force" is altogether abandoned. These ideas are again supplemented by astronomical illustrations, even the tides being worked into the scheme; and after this we have more vector calculus, with Stokes's theorem in the vector notation.

Dr. Jaumann next discusses rigid bodies, rigidity itself being defined by a vector equation! He discusses the constants of inertia, and solves some very elementary problems, and then passes on to a sketch of acoustics.

The last principal division of the book deals with deformable media—elastic solids, liquids, and gases. The treatment here is good so far as it goes, but too slight to be very satisfying.

Considering the work as a text-book, it must be said that the difficulty of the vectorial methods so freely used is hopelessly out of proportion to the results achieved. The student who has mastered the whole machinery of the treatise will still be unable to solve for himself any but the most rudimentary of the actual problems of dynamics. The author seems to overlook the cardinal fact that the solution of every moving material system depends ultimately on the integration of the associated differential equation, or some equivalent process, and that this is the really difficult part of the subject, the rest being child's play in comparison. A book which devotes scores of pages to symbols and formulæ, and yet never brings the reader into close grip with this essential kernel of the subject, is open to the charge of beating about the bush.

GREATER AUSTRIA.

Geologie der Umgebung von Sarajevo. By Ernst Kittl. Part iv. of the *Jahrbuch der k.k. geologischen Reichsanstalt* for 1903. (Vienna: R. Lechner, 1904.)

THIS general essay, with its plates of fossils and numerous geological sections in the text, corresponds to one of the memoirs on special districts issued by our own Geological Survey. It includes, moreover, a folded geological map on the scale of 1:75,000, and is thus a complete guide for future scientific visitors. The map itself reminds us of the charm of the Bosnian capital, set in its semicircle of craggy hills, where the gorge of the Miljačka broadens out towards the alluvial basin of Ilidže. We trace the mountain-road from the Ivan Pass coming out suddenly on this cultivated plain, and see again the minarets of Sarajevo shining like white masts under the background of Triassic precipices.

The author's introduction shows how the geological survey by Austrian observers followed hard upon the capture of the city, which had risen fanatically to arms. The famous ammonite-locality of Han Bulog, on the way to Mokro, was thus discovered as early as 1880; and the important part played by Triassic rocks east of Sarajevo was made known by

Bittner and Kellner, and in 1892 by the author, who was sent by von Hauer to collect for the museum in Vienna. The whole Alpine Trias seems well represented near the city, some of the massive limestones, rich in Diplopora, being spoken of as "Riffkalke." The red limestone with Ptychites, the rock best known in our collections, is on an Upper Muschelkalk horizon. While the Eocene period is probably represented by a Flysch-facies, the Oligocene and Miocene lagoons and freshwater lakes show that the mountain-land of Bosnia was rising above the sea in Middle Cainozoic times.

The author's detailed descriptions of the region, district by district, are illustrated by sections drawn on a correct vertical and horizontal scale, and by occasional sketches and photographic views. As a type of the sketches, we may mention the effective Fig. 16 (p. 611), showing the rounded forms of the Flysch deposits banked and sometimes faulted against the scarped Triassic masses to the east. Another section (p. 639) shows well how the Flysch strata, extending north towards Doboj and the great Hungarian plain, have been tilted and overfolded during the orogenic movements of the Dinaric Alps, which continued, as we now know, far into Pliocene times. The steep forms of the lowland landscape, cut into by frequent streams, are readily appreciated from the section.

The palæontological portion of the memoir records fossils from the "Kulmschiefer," including, curiously enough, *Modiola lata*, described by Wheelton Hind as recently as 1896. The author supports (p. 671) E. Haug and J. P. Smith in restoring Goniatites as a restricted generic term, so that we again have *Goniatites crenistria* and *truncatus*, as well as *sphaericus* and *striatus*. Osmanoceras and Tetragonites are described as new genera of goniatites. The Bellerophon-beds of the Upper Permian yield, amid a fairly rich fauna, Promyalina, a new member of the Aviculidæ. These forms, and a number of new species, are suitably figured, either in the text or in the plates. It is pleasant to recall the bookshops in Sarajevo on the way to the bazaar and the river-side, where this last product of Austrian investigation will appear for sale under the shadow of the Sultan's mosque.

G. A. J. C.

ECONOMIC SCIENCE.

Economic Essays by Charles Franklin Dunbar. Edited by O. M. W. Sprague, with an introduction by F. W. Taussig. Pp. xvii+372. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1904.) Price 10s. 6d. net.

NO American economist has been held in higher repute for judiciousness, breadth of view, and "soundness" than Charles Franklin Dunbar, professor of political economy at Harvard from 1871 until his death in 1900, sometime Dean of the college (between 1876 and 1882), and later Dean of the faculty of arts and sciences. But his output was never extensive, perhaps because the university teaching of political economy was not his first choice, or at any rate not his first calling. It was not until Prof. Dunbar had attained the ripe age of forty-one that he was appointed to his professorship at Harvard. Previously he had engaged in newspaper work, and had edited between 1859 and 1869 the *Boston Daily Advertiser*. To the work of the editorship of this paper Prof. Dunbar returned for a brief space to fill a breach at a time of crisis in 1884.

Having taken to the profession of teaching after engaging in practical affairs and feeling the excitements of politics, it is somewhat remarkable that Prof. Dunbar's interests after his appointment at Harvard should have been "academic" to so exclusive an extent. He studiously avoided making contributions to magazines upon the economic aspects of current events, and appears to have held that it was the main duty of the economist to trace the leading trends of social forces rather than to spend his energies in directing minor circumstances. Prof. Dunbar's best known work was done upon the subject of banking, and we are told by Prof. Taussig in his introduction to this collection of his late colleague's economic essays that he had meditated a comprehensive treatise relating to America upon the wider subject of which banking is a part, namely, financial history. Prof. Dunbar's little "History of Banking" is read to-day by all students of economics of this country and the United States at least.

The collection of essays before us contains a good deal of material that was not easily accessible previously, and some matter that is now published for the first time, upon the range of subjects which Dunbar made peculiarly his own. Eight out of the twenty essays included deal specifically with banking, and some of them are valuable contributions to our knowledge of the history of banking—for instance, the two dealing with early banking schemes in England and the Bank of Venice. Eight more essays are concerned more particularly with finance, for example, analyses of certain crises, the examination of the direct tax of 1861, and the discussion of the precedents followed by Alexander Hamilton. The remaining four essays arose out of the author's other chief interest, namely, the literature of classical economics; they are entitled "Economic Science in America, 1776–1876," "The Reaction in Political Economy" (written in 1886), "The Academic Study of Political Economy," and "Ricardo's Use of Facts." Certain of these essays were executed so long ago as almost to have become themselves a part of the old literature of classical economics; but, taken as a whole, they will prove enlightening even to economists who have benefited from the analysis effected and researches carried out since Prof. Dunbar's discussions appeared, for without exception the essays collected in this volume are thorough, scholarly, well pondered, and finely proportioned. Prof. Sprague's work of editorship appears to have been done admirably. All students of economics will be grateful to him for having made a collection of Prof. Dunbar's scattered writings and brought to the press the work which he left behind in manuscript.

OUR BOOK SHELF.

Beiträge zur Physik der freien Atmosphäre. Edited, with the cooperation of a number of distinguished meteorologists, by R. Assmann (Berlin) and H. Hergesell (Strassburg). Vol. i. Part i. (Strassburg: Trübner, 1904.)

ON receiving the first number of a new periodical, the question of the need and room for such a publication first rises to one's thoughts. It must be admitted that it is not easy to see the necessity for a magazine so highly specialised as the one before us. That the investigation of the upper atmosphere is a separate branch of study in itself is very questionable; and there are already the *Meteorologische Zeitschrift*, the *Veröffentlichungen der internationalen Kommission für wissenschaftliche Luftschiffahrt,* and the *Illustrierte Aëronautische Mitteilungen,* all suitable for the discussion of such investigations.

The subject-matter of this first number of the *Beiträge* is exceedingly interesting, and of no little importance. It contains three articles, each by a high authority on the subject dealt with.

The first, by Prof. Hergesell, is devoted to proving that kites can be raised to great heights quite independently of the weather conditions where a large expanse of water and a high-speed motor-boat are at the disposal of the observer, this being the same result as that arrived at by Rotch and by Dines. The more immediate object of the present article is to urge the possibility and necessity of founding an observatory on Lake Constance specially devoted to the investigation of the upper atmosphere.

In the second article Prof. Assmann describes "a year's simultaneous kite ascents in Berlin and Hamburg," with special reference to the existence of a warm current of air flowing almost constantly between 500 metres and 1000 metres above the surface. That such a current should exist is very interesting, and further observations as to its extent, strength, and permanency are very much to be desired.

The remaining article treats of the methods employed by Dr. A. de Quervain in determining the paths traversed by balloons sent up with registering instruments only. The methods described can only be employed so long as the balloon remains within the range of vision of a telescope; they are really trigonometrical. The first is the simple method of two theodolites at the ends of a base line, and the second similar, with the exception that only one theodolite is used, the heights of the balloon at the moments of observing with the theodolite being obtained later from the curve drawn by the barograph carried with the balloon.

Articles for future numbers, which are to be published as may be found convenient, are promised by Prof. Sprung, Prof. Wiechert, Dr. J. Maurer, and Dr. A. de Quervain. G. C. S.

The Inventor's Guide to Patent Law and the New Practice. By James Roberts, M.A., LL.B. Pp. viii+109. (London: John Murray, 1905.) Price 2s. 6d. net.

THIS is a well written handbook on British patent law and practice in which the inventor will find information of use to him. The new practice referred to in the title is the search by officials of the Patent Office for anticipations within the fifty years prior to an application, and the possible enforced statement as to these which the patentee may have imposed upon his own specification.

While the information derived from a search by officials of the Patent Office may be of the greatest use to a patentee, there is considerable doubt as to the advantage either to the patentee or to the community of allowing what may in reality be a specification of a valuable invention to be marred by an official statement as to certain prior specifications. There is a fear that an official with insufficient experience of practice either in works or in the Chancery Court may attach too great importance to what are known as paper anticipations, and by insisting on referring to them prevent a patent which otherwise might have been the basis of a successful manufacturing process, and be good enough to stand attack in the courts, from being even looked at by any manufacturer. However this may be, it is impossible to cast any doubt upon the Patent Office without paying a tribute to the great courtesy with which the humblest stranger who goes there is met, and the help that he is sure to receive short of professional advice. The library, too, and its arrangement is an admirable feature.

References to large standard works on patent law are very numerous, and will be of great service to the reader who desires more detailed information on difficult points than can possibly be given in a moderate compass. B.

A Manual of Mining. By M. C. Ihlseng and E. B. Wilson. Fourth edition. Pp. xvi+723. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 21s. net.

BASED on the course of lectures delivered at the School of Mines of Colorado, Prof. Ihlseng's book, which is regarded in America as the best text-book on the subject, has been enlarged under the joint authorship of Mr. Wilson to include coal mining, which received scant attention in previous editions. Excepting that ore dressing and coal washing are not touched upon, it now covers much the same ground as Sir C. Le Neve Foster's "Elements of Mining and Quarrying." The arrangement is, however, altogether different. The book is divided into two parts, mining engineering and practical mining. The former deals with prospecting, preparatory work, methods of mining, power generation, hoisting machinery, electric generation and water power, hoisting machinery and underground conveyances, underground haulage systems, wire rope transmission, the compression of air, pumping, mine gases, ventilation, distribution of air, the illumination of mines, and accidents in mines.

The second part deals with shafts, sinking in running ground, timbering, driving drifts, tunnels and gangways, drilling and boring machines for explorations, miners' tools, channelers, drills and coal-cutters, and blasting. It is difficult to see the object of this division into mining engineering and practical mining. In this country it is not usual to draw a sharp distinction between theory and practice in engineering work. Moreover, the order of the chapters in each section does not appear to be so logical as that followed in English and Continental text-books. Thus on p. 30 the steam shovel is described, but it is not until p. 621 that we come to a description of the ordinary pick and shovel. On p. 47 the blasting of coal is dealt with, but it is not until p. 685 that the operation is described and the theory of blasting explained. The book contains much useful information, but the lack of method in the arrangement cannot fail to militate against its use as a text-book. The illustrations, many of which are excellent, are largely borrowed from makers' catalogues, and are not nearly so useful for educational purposes as rough sketches specially drawn would be.

The frequent misprints in figures in the index and in the references should have been carefully guarded against in a book intended for students. Several

names also are incorrectly printed, and the references given at the end of the chapter on mine illumination mostly refer to ventilation. On p. 681 the student is taught to load a hole "with nitroglycerine by pouring from a tin cup upon the fuse with its cap and covering the mass with water." Evidently the Coal Mines Regulation Act has no analogue in a country where, as the authors point out, "each new camp, untrammelled by tradition to keep it in the rut of prejudice, displays its genius for organisation and absorbs the latest devices, tried and true."

The Practical Photographer. (Library Series.) Edited by Rev. F. C. Lambert. No. 16, *Pictorial Composition.* Pp. xx+64. No. 17, *Animal Photography.* Pp. xxiv+64. (London: Hodder and Stoughton, 1905.) Price 1s. net.

In the first of these books the editor gives an interesting account of the pictorial work of Bernard Alfieri, illustrating it with six excellent reproductions of this well-known worker's studies. Among the other sections of the book, which are written by various authors, those on the principles of composition, by Arthur Burchett, and some notes on composition in landscape, by Horace Mummery, will be found of great practical value. In these the pen and ink sketches showing the several methods of producing balance in pictures call for special attention. Other articles, such as that on the arrangement of the foreground, are well worth perusing. Numerous well reproduced illustrations, serving as examples of good and bad composition, accompany the text. The second of the above books appeals to another class of photographers, for, with the exception of the editor's article on the pictorial work of Viscount Maitland, it is devoted to the photography of animals. Like the former book; numerous authors have contributed to the text, and a very wide range of points of view is included. It is written on the same practical lines, and is accompanied by fifty-five well selected illustrations. Both volumes will add to the value of this useful library series.

Détermination des Espèces minérales. By L. M. Granderye. Pp. 184. (Paris: Gauthier-Villars, n.d.) Price 2.50 francs.

In this little book, which is a publication of the "Encyclopédie scientifique des Aide-Mémoire," the author has apparently attempted to devise a royal road for the determination of a mineral species. For this purpose he has compiled a number of lists of the more common minerals arranged according to physical characters, viz. crystal-system, colour, structure, density, &c., and has supplemented these with some instructions on blowpipe analysis and chemical examination in the dry way. Such lists are certainly of great value for determination purposes, but, as regards the more common minerals, at any rate, it would be a mistake to encourage the student to rely upon any methodical scheme of determination to the neglect of an acquisition of a thorough knowledge of the characters of the individual species. For many minerals, especially with imperfectly crystallised specimens, we fear these tables would prove an uncertain guide in the absence of any observations of the optical characters or of chemical examination in the wet way. In Brush and Penfield's standard work on determinative mineralogy it is true that no account is taken of the optical characters, but sufficient importance is given to chemical tests in the wet way. The tables are not altogether free from errors and misprints; thus a saline taste is attributed to sodalite, rhodonite is described as a carbonate, and the density of wolframite is given as 5·5 on one page and 7·5 on another. The book concludes with a list of 600 minerals with their principal characters, viz. density, hardness, &c.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Dynamical Theory of Gases and of Radiation.

I AM glad to have elicited the very clear statement of his view which Mr. Jeans gives in NATURE of April 27. In general outline it corresponds pretty closely with that expressed by O. Reynolds in a British Association discussion at Aberdeen (NATURE, vol. xxxii. p. 534, 1885). The various modes of molecular motion are divided into two sharply separated groups. Within one group including the translatory modes, equipartition of energy is supposed to establish itself within a small fraction of a second; but between the modes of this group and those of vibration included in the other group, equipartition may require, Mr. Jeans thinks, millions of years. Even if minutes were substituted for years, we must admit, I think, that the law of equipartition is reconciled with all that is absolutely proved by our experiments upon specific heat, which are, indeed, somewhat rough in all cases, and especially imperfect in so far as they relate to what may happen over long intervals of time.

As I have already suggested, it is when we extend the application of the law of equipartition to the modes of æthereal vibration that the difficulties thicken, and this extension we are bound to make. The first question is as to the consequences of the law, considered to be applicable, after which, if necessary, we may inquire whether any of these consequences can be evaded by supposing the equipartition to require a long time for its complete establishment. As regards the first question, two things are at once evident. The energy in any particular mode must be proportional to θ, the absolute temperature. And the number of modes corresponding to any finite space occupied by the radiation, is infinite. Although this is enough to show that the law of equipartition cannot apply in its integrity, it will be of interest to follow out its consequences a little further. Some of them were discussed in a former paper,[1] the argument of which will now be repeated with an extension designed to determine the coefficient as well as the law of radiation.

As an introduction, we consider the motion of a stretched string of length l, vibrating transversely in one plane. If a be the velocity of propagation, ξ the number of subdivisions in any mode of vibration, the frequency f is given by

$$f=a\xi/2l \quad . \quad . \quad . \quad . \quad . \quad . \qquad (1)$$

A passage from any mode to the next in order involves a change of unity in the value of ξ, or of $2lf/a$. Hence if e denote the kinetic energy of a single mode, the law of equipartition requires that the kinetic energy corresponding to the interval df shall be

$$2le/a.df \quad . \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

In terms of λ the wave-length, (2) becomes

$$2le/\lambda^2.d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \qquad (3)$$

This is for the whole length of the string. The longitudinal *density* of the kinetic energy is accordingly

$$2e/\lambda^2.d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \qquad (4)$$

In each mode the potential energy is (on the average) equal to the kinetic, so that if we wish to reckon the whole energy, (4) must be doubled. Another doubling ensues when we abandon the restriction to one plane of vibration; and finally for the total energy corresponding to the interval from λ to $\lambda+d\lambda$ we have

$$8e/\lambda^2.d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \qquad (5)$$

When we proceed to three dimensions, and consider the vibrations within a cube of side l, subdivisions may occur in three directions. In place of (1)

$$f=a/2l.\sqrt{(\xi^2+\eta^2+\zeta^2)} \quad . \quad . \quad . \quad . \qquad (6)$$

where ξ, η, ζ may assume any integral values. The next step is to ascertain what is the number of modes which corresponds to an assigned variation of f.

If the integral values of ξ, η, ζ be regarded as the

[1] "Remarks upon the Law of Complete Radiation," *Phil. Mag.*, xlix. p. 539 June, 1900.

coordinates of a point, the whole system of points constitutes a cubic array of volume-density unity. If R be the distance of any point from the origin,

$$R^2 = \xi^2 + \eta^2 + \zeta^2;$$

and the number of points between R and R+dR, equal to the included volume, is

$$4\pi R^2 dR.$$

Hence the number of modes corresponding to df is

$$4\pi(2l/a)^3 f^2 df,$$

or in terms of λ

$$4\pi . 8l^3 . \lambda^{-4} d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \qquad (7)$$

If e be the kinetic energy in each mode, then the kinetic energy corresponding to $d\lambda$ and to unit of volume is

$$32\pi e\lambda^{-4} d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \qquad (8)$$

Since, as in the case of the string, we are dealing with transverse vibrations, and since the whole energy is the double of the kinetic energy, we have finally

$$128 . \pi . e . \lambda^{-4} d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \qquad (9)$$

as the total energy of radiation per unit of volume corresponding to the interval from λ to $\lambda + d\lambda$, and in (9) e is proportional to the absolute temperature θ.

Apart from the numerical coefficient, this is the formula which I gave in the paper referred to as probably representing the truth when λ is large, in place of the quite different form then generally accepted. The suggestion was soon confirmed by Rubens and Kurlbaum, and a little later Planck (*Drude Ann.*, vol. iv. p. 553, 1901) put forward his theoretical formula, which seems to agree very well with the experimental facts. This contains two constants, h and k, besides c, the velocity of light. In terms of λ it is

$$E\, d\lambda = \frac{8\pi ch}{\lambda^5} \frac{d\lambda}{e^{ch/k\lambda\theta} - 1} \quad . \quad . \quad . \qquad (10)$$

reducing when λ is great to

$$E\, d\lambda = 8\pi k\theta\lambda^{-4} d\lambda \quad . \quad . \quad . \quad . \quad . \qquad (11)$$

in agreement with (9). $E\, d\lambda$ here denotes the volume-density of the energy of radiation corresponding to $d\lambda$.

A very remarkable feature in Planck's work is the connection which he finds between radiation and molecular constants. If N be the number of gaseous molecules in a cubic centimetre at 0° C. and under a pressure of one atmosphere,

$$k = \frac{1 \cdot 013 \times 10^6}{273 N} \quad . \quad . \quad . \quad . \quad . \quad . \qquad (12)$$

Though I failed to notice it in the earlier paper, it is evident that (9) leads to a similar connection. For e, representing the kinetic energy of a single mode at temperature θ, may be identified with one-third of the average kinetic energy of a gaseous molecule at that temperature. In the virial equation, if N be the total number of molecules,

$$\tfrac{3}{2}pv = \Sigma \tfrac{1}{2} m V^2 = 3Ne,$$

so that

$$e = pv/2N \quad . \quad . \quad . \quad . \quad . \quad . \qquad (13)$$

If we apply this to one cubic centimetre of a gas under standard conditions, N has the meaning above specified, $v = 1$, and $p = 1 \cdot 013 \times 10^6$ C.G.S. Accordingly, at 0° C.

$$e = 1 \cdot 013 \times 10^6 / 2N,$$

and at θ°

$$e = \frac{1 \cdot 013 \times 10^6 \times \theta}{2 \times 273 N} \quad . \quad . \quad . \quad . \qquad (14)$$

Introducing this into (9), we get as the number of ergs per cubic centimetre of radiation

$$\frac{64 . \pi . 1 \cdot 013 . 10^6 . \theta . d\lambda}{273 . N . \lambda^4} \quad . \quad . \quad . \qquad (15)$$

θ being measured in centigrade degrees. This result is eight times as large as that found by Planck. If we retain the estimate of radiation used in his calculations, we should deduce a value of N eight times as great as his, and probably greater than can be accepted.

A critical comparison of the two processes would be of interest, but not having succeeded in following Planck's reasoning I am unable to undertake it. As applying to all wave-lengths, his formula would have the greater value if satisfactorily established. On the other hand, the reasoning which leads to (15) is very simple, and this formula appears to me to be a necessary consequence of the law of equipartition as laid down by Boltzmann and Maxwell. My difficulty is to understand how another process, also based upon Boltzmann's ideas, can lead to a different result.

According to (15), if it were applicable to all wave-lengths, the total energy of radiation at a given temperature would be infinite, and this is an inevitable consequence of applying the law of equipartition to a uniform structureless medium. If we were dealing with elastic solid balls colliding with one another and with the walls of a containing vessel of similar constitution, energy, initially wholly translational, would be slowly converted into vibrational forms of continually higher and higher degrees of subdivision. If the solid were structureless, this process would have no limit; but on an atomic theory a limit might be reached when the subdivisions no longer included more than a single molecule. The energy, originally mechanical, would then have become entirely thermal.

Can we escape from the difficulties, into which we have been led, by appealing to the slowness with which equipartition may establish itself? According to this view, the energy of radiation within an enclosure at given temperature would, indeed, increase without limit, but the rate of increase after a short time would be very slow. If a small aperture is suddenly made, the escaping radiation depends at first upon how long the enclosure has been complete. In this case we lose the advantage formerly available of dividing the modes into two sharply separated groups. Here, on the contrary, we have always to consider vibrations of such wave-lengths as to bear an intermediate character. The kind of radiation escaping from a small perforation must depend upon the size of the perforation.

Again, does the postulated slowness of transformation really obtain? Red light falling upon the blackened face of a thermopile is absorbed, and the instrument rapidly indicates a rise of temperature. Vibrational energy is readily converted into translational energy. Why, then, does the thermopile not itself shine in the dark?

It seems to me that we must admit the failure of the law of equipartition in these extreme cases. If this is so, it is obviously of great importance to ascertain the reason. I have on a former occasion (*Phil. Mag.*, vol. xlix. p. 118, 1900) expressed my dissatisfaction with the way in which great potential energy is dealt with in the general theory leading to the law of equipartition. RAYLEIGH.

May 6.

The Cleavage of Slates.

IN his critique of Dr. Becker's theory of slaty cleavage in NATURE of May 4, "A. H." says that it is substantially the same as mine, and rightly objects that, "if the cleavage plane were a plane of shearing it would correspond with a circular section of the ellipsoid" of distortion. It is true that I made that suggestion in the body of my first paper on cleavage in the *Geological Magazine*, 1884, but in a postscript to that paper I stated that a conversation with Mr. Harker had led me to the conclusion that the cleavage surfaces are determined by the position of the principal axes of the ellipsoids of distortion produced by a shearing movement, and to this view I have ever since adhered.

"A. H." says that "there are many slates in which the strain ellipsoid is actually presented in deformed spherical concretions or colour-spots." Is this certain? Is it not probable that these discolorations took place after the rock became a slate? In that case the chemical influence emanating from the foreign particle, usually obvious in the centre of the spot, found the greatest conductivity in the direction of the longest axis of the ellipsoid, the next greatest along the mean axis, and very little along the least. It is from this property of little conductivity across the cleavage that slates are eminently suited for roofing. I have a piece of a school slate with two sharply defined oval patches, of each of which the two diameters are 25 mm. and 16 mm. The thickness of the slate is less than 4 mm., and yet the discoloration does not pass through to the other side. If these spots are sections of ellipsoids formed out of spheres by compression, the resulting condensation must have been incredibly enormous. The spots in Borrowdale slates are of a different character from spots of dis-

coloration. They existed in the rock before cleavage was induced. Many of them are broken up like broken egg-shells. Those which are complete lie with their longest axes in the plane of cleavage, and would well agree with the theory that they were deformed along with the enveloping rock by a shearing process, and that the plane of the greatest distortion was the plane of cleavage.

In my paper on cleavage and distortion in the *Geological Magazine* I pointed out that it is to Sir John Herschel that we are indebted for the theory of the "molecular movement," which, I remarked, was in fact a "shear"—a term which has now been universally accepted for this kind of action in rocks; and in my "Physics of the Earth's Crust" I have explained how the crumpling in the harder and cleavage in softer layers of a rock would simultaneously arise from such a shearing movement. O. FISHER.

Harlton, Cambridge, May 8.

A Relation between Spring and Summer.

A FAIR idea of the larger fluctuations of a given meteorological element may be had by means of a two-fold smoothing process, *e.g.* adding the series of values in groups of five (1 to 5, 2 to 6, 3 to 7, &c.), and then doing the same with those sums. In each case the sum is put opposite the middle member of the group.

When this is done with (*a*) the amounts of rainfall in spring (March to May) at Greenwich since 1841, and (*b*) the numbers of warm months in summer (same place and period), we have the two curves in the diagram. The

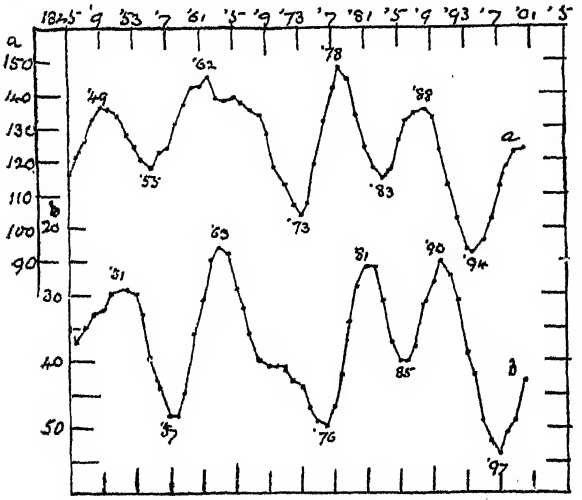

FIG. 1.—Smoothed curves of spring rainfall and summer warmth.

lower one (that for summer) is *inverted*, so that its crests represent *few* warm months, or coolness.

One must be struck, I think, with the similarity of the curves; four long waves (roughly) in each, those of the lower curve lagging in phase somewhat (one to three years) on those of the upper curve. The four *centres of wetness*, as we may call them, of the spring series are followed at a brief interval by four *centres of cold* in the summer series, and the four *centres of dryness* in the former, at much the same interval, by four *centres of warmth* in the latter.

Let us look briefly at the nature of those centres, and we may do so by indicating, first, the character of the group of five springs about each of the dates 1849, 1862, 1878, and 1888 (wave-crests of upper curve), and the corresponding summer groups (wave-crests of lower curve). We find in each group of five springs an excess in the total rainfall, and at least three of the five wet; further, in each summer group a small number of warm months.

5 Springs about	Rainfall	Relation to av.	Wet Springs	5 Summers about	Warm months
1849	28·5	+3·8	3	1851	6 out of 15
1862	28·5	+3·8	3	1863	5 ,,
1878	31·2	+6·5	4	1881	3 ,,
1888	27·9	+3·2	3	1890	3 ,,

Making a similar comparison of the centres of dryness in spring with the centres of warmth in summer, we have:

5 Springs about	Rainfall	Relation to av.	Wet Springs	5 Summers about	Warm months
1855	23·9	−0·8	2	1857	12 out of 15
1873	20·2	−4·5	1	1876	11 ,,
1883	22·3	−2·4	1	1885	10 ,,
1894	15·9	−8·8	0	1897	12 ,,

Here the relations are all of an opposite character.

To what are those long waves of variation to be attributed? And can any physical explanation be given of the sequence which has been indicated? Perhaps some of your readers may be able to throw light on these points. I will only remark that there is no obvious connection with the sun-spot cycle. Thus the first two crests in the upper curve come close after maxima (1848 and 1860), while the two latter are near minima (1878 and 1889).

With regard to the point now reached by this curve (*a*), the rainfall of the present spring (already in excess, May 10) should extend it upwards, but it must apparently be near another crest. Some help in forecasting our summers might perhaps be derived from a consideration of the facts above given. ALEX. B. MACDOWALL.

Fictitious Problems in Mathematics.

IN NATURE of April 27 (vol. lxxi. p. 603) your reviewer finds fault with Cambridge examiners for endowing bodies with the most inconsistent properties in the matter of perfect roughness and perfect smoothness—"A perfectly rough body placed on a perfectly smooth surface." Your reviewer adds, the average college don forgets that roughness or smoothness are matters which concern *two surfaces*, not *one* body.

Will your reviewer give a reference to some page of Whittaker's book (that under review), or to some page of any other text-book used in the last half-century at Cambridge, in support of his charge against Cambridge examiners? Fifty years ago, William Hopkins was still directing the mathematical teaching of Cambridge, and enforcing the conservation of energy where friction is taken into consideration. A perfectly rough sphere moving on a rough surface is intended to mean that, during the motion considered, the sphere rolls without any slip. "A perfectly rough sphere moving on a smooth surface" would no doubt be equivalent to "A sphere moving on a smooth surface"; but where does the phrase occur?

AN OLD AVERAGE COLLEGE DON.

THE alleged inaccuracies of language in stating the assumed conditions of smoothness or roughness prevailing between two bodies in contact are unfortunately so common that it is the exception rather than the rule to find any problem in which these conditions are correctly worded. In working through a chapter of Besant's "Dynamics" with a class the other day, I came across no less than two problems in which a "perfectly rough" body was supposed to be in contact with a second body which in turn rested against a third "perfectly smooth" body. In these cases the framer of the question carefully avoided giving any information as to the roughness or smoothness of the middle body, so that the inaccuracy of language might easily be overlooked. But this does not apply to the following example:—

"A person is placed at one end of a perfectly rough board which rests on a smooth table. Supposing he walks to the other end of the board, determine how much the board has moved. If he stepped off the board, show how to determine its subsequent motion" (Routh, "Elementary Rigid Dynamics," 1882 edition, p. 69, example 4).

At the time of writing the review I was quite unaware that such an example had found its way into a text-book written by so careful a teacher of applied mathematics as Dr. Routh, and it says much for the prevalence at Cambridge of these erroneous forms of statement that this wording failed to attract the author's attention. Since writing my review, it has been brought to my notice that similar inaccuracies widely prevail in the statement of problems involving so-called "perfectly elastic" or "inelastic bodies." THE REVIEWER.

SCIENTIFIC RESULTS OF THE NATIONAL ANTARCTIC EXPEDITION.

THE April number of the *Geographical Journal* contains a series of short papers by members of the *Discovery* Expedition which may be regarded as forming together a kind of "preliminary report" on the work of the expedition in the Antarctic regions. These papers are five in number; Captain Scott deals with the general geography, Mr. Ferrar with physical geography, Lieut. Royds with meteorology, Dr. Wilson with seals and birds, and Mr. Hodgson with the marine biological collections. Captain Colbeck also contributes a paper on the Antarctic sea-ice, discussing the observations made on the *Southern Cross* in 1898–1900 and on the *Morning* in 1902–4.

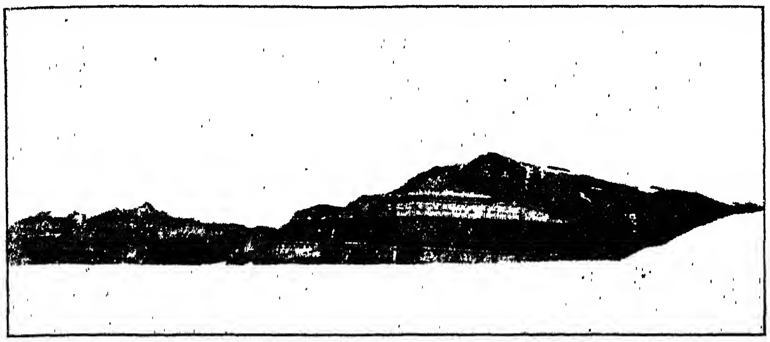

FIG. 1.—Beacon Heights. Sandstone and Basalt.

Without attempting to summarise the contents of each paper, we may try to indicate what are the chief problems which have attracted the attention of the members of the expedition, and what materials they have provided for their discussion. All things considered, perhaps the most important questions concern the remarkable ice conditions observed by Captain Scott and Mr. Ferrar. "There are innumerable glaciers on the coast of Victoria Land," says Captain Scott, "but the great majority merely discharge local *névé* fields lying in the valleys of the coastal ranges. Very few run back to the inland ice, and these may be divided into two classes—the living and the dead. In the long stretch of coast between Cape Adare and Mount Longstaff, over 11° of latitude, there appears to be only four living ice-discharges from the inland." "The Ferrar glacier is typical of the dead glaciers; the ice lies in the valley practically stationary, and gradually wasting away from the summer thawing." "The Ferrar glacier probably contains as much ice as any hitherto known in the world; the Barne and Shackleton glaciers contain a great deal more, and since they are now in such a diminished state it is interesting to think what vast streams of ice they must have been at their maximum." "To what extent the inland ice sheet stood above its present level is also interesting to surmise; one would submit a possibility of 400 or 500 feet."

Again, referring to the Great Barrier, Captain Scott says:—"... the barrier edge sixty years ago was in advance of its present position, in places as much as 20 or 30 miles."

These facts, along with many others, such as observations by Dr. Wilson and Mr. Ferrar of moraines and erratics high above the level of the ice-sheet, all go to show that "the majority of curious and often vast ice-formations met with in the Ross sea must be regarded, not as the result of present day conditions, but as the rapidly wasting remnants of a former age."

One of the most remarkable observations is that while, as just explained, the ice from Victoria Land does not make any important contribution to the ice-barrier in the Ross Sea, that ice is moving northward at the rate of about 600 yards in a year. Captain Scott believes that the greater portion of the ice-sheet in the Ross Sea is afloat, and that the high coast line of Victoria Land continues southward in a direction towards Graham's Land. Here there is obviously a fruitful source of discussion, but whatever the result, with regard to the distribution of land and sea, it may be taken as proved beyond doubt that the ice in at least this part of the Antarctic regions is in a state of fairly rapid retreat, and it is known that the same thing is happening in the Arctic regions.

Mr. Ferrar's geological observations in Victoria Land have an important bearing on the problem of the outline of the land mass, as well as great intrinsic value. In the Royal Society range a gneissic platform was found, probably of Archæan age, and above it in order are granites, sandstone, and basalt. The granites are, according to Mr. Ferrar, of two ages; the sandstone is 2000 feet thick, while the basalt caps the sandstone, forming plateaux which have been dissected by denudation, and probably also broken up by faulting. At the base of the basalt a thin carbon-

FIG. 2.—Mount Erebus with smoke.

aceous seam, not more than one-eighth of an inch in thickness, was found. This seam yielded carbonaceous matter which it is agreed must be due to vegetation, but the plant remains are unfortunately beyond identification.

With regard to questions of climate, it is more necessary to await the full discussion of the observations, but a number of interesting points have already cropped up. The smoke from Mount Erebus blew almost persistently to the east, but every record of the Ross Expedition describes it as going to the west. At the *Discovery's* winter quarters the prevailing winds were south-easterly; the observers are strongly of opinion that this is a local phenomenon. Captain Scott's general conclusions are to the effect that the prevailing direction of the surface winds is west-by-south throughout the winter, and more southerly during summer; and that there is no snowfall except in the summer and on the rare occasions when the wind blows almost due south. These snow-bearing winds were warm, rising to a temperature of 10° C. to 15° C. even in the depth of winter. Their occurrence seems somewhat difficult of explanation, but they obviously have a very important bearing on the relation of temperature and quantity of moisture in causing glacial periods, and modifying their intensity.

In describing the distribution of Antarctic seals, Dr. Wilson records that the Weddell seal was the one most often met with near the land. The expedition made an addition to the list which Dr. Wilson thinks "will prove to be a wanderer from the Southern Ocean islands, representing the now rare sea-elephant of the M'Quaries." Dr. Wilson thinks little of the prospects of the Antarctic seal-fishery, notwithstanding the increased demand for skins of hair-seals, the chief reason being that few skins escape the unsightly scars inflicted by the killer whale. The expedition collected much valuable material with regard to doubtful species of birds, especially cases like the emperor and king penguins and the white-winged and royal albatrosses, where in the adults it is hard to find specific differences, although the chicks are quite distinct.

FIG. 4.—Emperor Penguin Rookery.

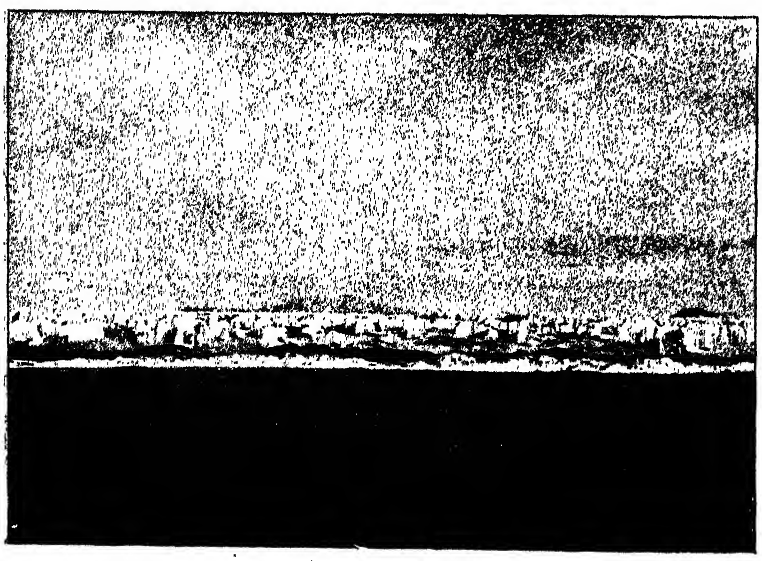

FIG. 3.—Pinnacled ice floating in McMurdo Bay.

Perhaps the most significant point in Mr. Hodgson's report is that, contrary to expectation, it was found that outdoor biological work could be carried on all the year round, "and that even with comfort." As a result, a continuous daily routine left no time for examining the material collected. Everything goes to show that animal life is very abundant in the southern seas, and a predominant feature is the enormous quantity of sponges. One organism, regarded as a Nemertine, though suspected to be something else, appeared when it arrived frozen at the ship to be "close on 20 feet long, of a light brown colour, and about the diameter of an ordinary boot-lace."

In summarising the observations on the sea ice, Captain Colbeck has "no hesitation in saying that the pack should be entered between long. 178° and 180° E., as early in December as possible."

THE STATE AND HIGHER EDUCATION.

MR. CHAMBERLAIN, in moving a vote of thanks to the Lord Chancellor—who as Warden of the University of Birmingham gave an address in Birmingham on May 13—delivered a speech emphasising the importance to the nation of higher scientific education. During his remarks Mr. Chamberlain directed attention to the fact that the University of

Birmingham is indebted to the local authority for an income of 6000*l.* a year, and referred regretfully to the circumstance that the neighbouring local authorities have not contributed very largely to the funds of the university. It must be admitted that the contribution of the city of Birmingham to its university is a handsome tribute to the value attached by the local authority to university instruction, and we join with the Chancellor of the university in hoping that suitable sums of money will be devoted in the near future by local authorities in adjoining areas to the purposes of higher education in the Midlands.

It is, however, to be regretted that Mr. Chamberlain made no reference on this occasion to the important principle—a principle he has conceded already more than once—that higher education, especially in science, is primarily a national charge. As was pointed out in the issue of NATURE for March 16, the present State grant to the University of Birmingham is 4500*l.*, an amount which compares unfavourably with the sum voted by the local city authority. Presiding at the annual meeting of the court of governors of the university on February 6 of this year, Mr. Chamberlain remarked:—

"I may say in passing that the liberality of, the local contribution is a ground for the claim which we make for some further State support. It is something that we have found that the Government are becoming alive to our needs and to our deserts, and that they have been able to double the sum previously given for university education. But we may bear in mind at the same time that the present Chancellor of the Exchequer has promised to double it again in his next Budget, and, therefore, I anticipate that from that source we shall receive a very considerable addition. I do not at all accept it as in any way a satisfaction of our demands, because it is my conviction that public opinion will soon insist upon larger sums being devoted to this purpose. When I think that we are spending thirteen millions a year at least on primary education I say the sum now given for the purpose of the highest education, the most profitable of all the investments we can make in that direction, is altogether inadequate."

If it were necessary many similar quotations could be made from Mr. Chamberlain's speeches, for he has always maintained enthusiastically the value of higher education, and recognised, at least in theory, the duty of the State to provide for it adequate financial assistance. It is noteworthy, indeed, that on the part of our leading statesmen there is an almost complete unanimity of opinion as to the paramount importance of higher scientific training for the citizens of a nation which expects to occupy a foremost place in the industrial and commercial pursuits of the world. The Lord Chancellor said in speaking to the undergraduates at Birmingham on Saturday last, that in his judicial capacity he has noticed that "the number of patents invented in Germany and brought over to England is very large indeed; the German Government has contemplated the improvement of its national resources by physical, chemical, and other scientific research, and has established places for physical investigation." Lord Halsbury might also have pointed out the amount of State aid to universities afforded in Germany. The yearly sum, found chiefly by the State, for the upkeep of the University of Berlin is 130,000*l.*, and six other universities each receive from the same source annual sums varying from 56,000*l.* to 37,000*l.*

It will be remembered that Sir Norman Lockyer said in his address in 1903, as president of the British Association, that the State does really concede the principle that higher education should be a national responsibility, by its contribution to our universities and colleges. Since that address was delivered the grant to university colleges has been increased, and it may now be said that the Treasury provides for higher education of the whole country something like the amount that is given by the State to the University of Berlin alone.

But in face of the fact that we have the concession by the Government of the principle we have maintained consistently in these columns, that university education, of the modern kind at least, should be provided by the State; and that our statesmen profess to appreciate the value of higher scientific study so far as our national welfare is concerned, and to trace to their colleges and laboratories for research the success of other nations competing with us in the struggle for national existence; no serious and statesmanlike action is taken by our Government to place our system of higher education upon a broad and generous foundation. Despite years of earnest advocacy by men of science, and repeated object lessons abroad of the advantages which early follow national sacrifices on behalf of education, little progress is made by us in the direction of supplying means to provide trained intelligences to perform the work of the country in the world's markets and manufactories. Yet, unless something in the direction adumbrated is done, knowing the earnest work which is being accomplished elsewhere, this country must, so far as industrial and economic prosperity are concerned, expect soon to take a third or fourth place in the competition of the nations.

A statesman imbued with the modern spirit, aware of present-day tendencies, possessed of the power of persuasion and clear exposition, would have little difficulty—if he really desired the best interests of the nation—in carrying the country with him by insisting that an adequate provision of higher education for those who will manage and control its industrial activities must be made a national charge.

MEETING OF THE BRITISH ASSOCIATION IN SOUTH AFRICA.

THE seventy-fifth meeting of the British Association, to be held in South Africa, under the presidency of Prof. G. H. Darwin, in August, promises to be of an unusually interesting character. Though on two previous occasions the association has met in the "British Dominions beyond the Seas," this is the first on which it will hold its annual meeting in the southern hemisphere and in a part of the British Empire so remote from its headquarters.

As early as the year 1900, the possibility of holding such a meeting was discussed by the council of the British Association in consultation with Sir David Gill, who, however, pointed out that the local circumstances were at that time unfavourable. Two years later, however, Sir David Gill informed the association that he was empowered to transmit an invitation to visit South Africa in 1905 on behalf of the various Governments, municipal, scientific, and commercial bodies in South Africa. Arrangements have now so far advanced as to enable us to give a preliminary account of the general features of the meeting and its probable character.

The invitation was issued on behalf of the above-mentioned bodies, and substantial financial assistance has been rendered by the South African Governments. The various centres to be visited are also making extensive progress, both financially and by way of private hospitality, to render the arrangements workable and adequate.

A central organising committee, under the chairmanship of Sir David Gill, has been formed to see to the general arrangements and coordination of the

work of the different centres to be visited by the association, and by means of correspondence, circulars, &c., to keep them in touch with each other and with the executive in England.

The centres, which are seven in number, are as follows:—Cape Town, Durban, Pietermaritzburg, Johannesburg, Bloemfontein, Kimberley, and Bulawayo. Influential local committees have been formed at all these places, the municipal authorities of which have taken a prominent part both in making general arrangements and in affording financial support. Subcommittees for finance, publications, excursions, and hospitality have been formed at the two chief centres (Cape Town and Johannesburg), and are now engaged in the respective parts of the work allotted to them. At the other centres where a stay of only a day or two is contemplated, special committees have also been formed. Details are as yet uncertain, but the following may be mentioned, though some of them are subject to slight revision.

The officers of the association and invited guests to the number of 200, along with ordinary members, will arrive by the *Saxon* at Cape Town on August 15, though a number have already booked their passage by steamers arriving at an earlier date. The presidential address will be delivered on the evening of the same day in the large new Town Hall, which has been placed at the disposal of the British Association by the municipal authorities of Cape Town, not only for this purpose, but also for the accommodation of the various sections should it prove suitable.

The sections will meet for the purpose of reading papers and for discussion on Wednesday, Thursday, and Friday, August 16, 17, and 18. The afternoons of these days will be partly devoted to excursions to places of interest, such as Table Mountain, Hout Bay, Simons Town, and Royal Observatory. The whole of Saturday, August 19, will be devoted to excursions.

The evenings will probably be devoted to a reception by the Mayor, and two lectures, one by Prof. Poulton on Burchell's work in South Africa, and another by Mr. C. V. Boys on physics.

On Saturday night, August 19, visitors will leave by a special steamer for Durban. In Natal an influential general committee has been formed by the Government, with local committees at Durban, Pietermaritzburg, and Ladysmith. On the evening of August 20 a lecture will be delivered at Durban and another on August 24 at Pietermaritzburg. As the reading of papers, discussions, receptions, &c., in Cape Colony will fully occupy all the time of the visitors, it is intended to afford as much facility as possible for independent action on the part of visitors in Natal, and special arrangements will be made by the Natal committee for visiting the battlefields and other places of interest.

The sectional work will be again resumed on arrival of the party at Johannesburg on Monday, August 28. There, as at Cape Town, a large and influential local committee has been formed, with subcommittees for finance, hospitality, publication, and excursions. The first-named subcommittee has already met with a ready response, both from the municipal authorities and from private sources, and the other committees are in capable hands. While the natural facilities for excursions to be found near the Cape peninsula are not to be met with here, the interest of the mining operations and gold extracting processes will be an adequate compensation, and a Friday's visit to Pretoria will be of special interest.

The proceedings will be begun at Johannesburg on Monday evening, August 28, and the presidential address there will be delivered on the Wednesday evening. In addition to sectional papers and discussions, there will be two lectures delivered at Johannesburg, one on distribution of power by Prof. Ayrton, another on steel as an igneous rock by Prof. Arnold, and one at Pretoria by Prof. Porter on mining.

Bloemfontein will be visited on Saturday, September 2. There also an influential local committee has been formed, and preparations are being made for the reception of visitors. A lecture will be delivered there on the Saturday night by Mr. A. R. Hinks on an astronomical subject.

At Kimberley, which will be reached on Tuesday, September 5, a large local committee has been formed, with subcommittees for special objects. Two lectures will probably be delivered here, one on a zoological subject by Mr. A. E. Shipley, and one on diamonds by Sir William Crookes. The De Beers Company has naturally taken a prominent part in the preparations, and will probably make this visit one of the most interesting.

Through the kindness of the Chartered Company a limited number of members of the British Association will be enabled to proceed from there to the Zambezi, where the Victoria Falls will be visited, and facilities will be afforded for the visit of a select party of specialists to the ancient ruins of Zimbabwe. A special committee at Bulawayo has been formed to make preparations there for the visit.

Special attention will be directed to certain interesting problems connected with the geological formation at the Victoria Falls, and Mr. G. W. Lamplugh, who will go out in advance to study this subject, will probably be able to give the results of his observations in an afternoon address to Section C.

Though this meeting of the association will be characterised by the number and variety of the places visited, a special feature will be the study of local scientific problems and discussions of a general nature such as fossil reptiles, Antarctica, &c. With this in view the South African Association for the Advancement of Science, with the support of the various Governments, is preparing a handbook, which will be a general review of the various branches of scientific activity in South Africa, the articles being contributed by actual workers in these subjects in the country. The book is now in an advanced stage of preparation, and a copy will be presented to each member of the association before leaving England.

SIR BERNHARD SAMUELSON, P.C., BART., F.R.S.

SIR BERNHARD SAMUELSON, F.R.S., who died on May 10 in his eighty-fifth year, will be remembered as one of the pioneers of the Cleveland iron trade, and a strenuous advocate of technical education. He exerted a great and formative influence upon an industry which owes its progress largely to the application of scientific methods, and the extension of facilities for technical education is largely due to his efforts.

Sir Bernhard Samuelson was born on November 22, 1820, and began in 1853 the business which speedily made the Cleveland district the greatest iron-producing centre in the world. Blast furnaces were erected near Middlesbrough, and in 1872–1880 collieries and ironstone mines were added. Not content with making pig-iron, the manufacture of finished iron was undertaken on an extensive scale, and no less than 25,000*l*. were spent in preliminary experiments in steel-making. The Britannia Ironworks at Middlesbrough, covering an area of twenty acres, have grown out of this enterprise.

He was the author of several reports on technical subjects to the House of Commons, including one on technical education of artisans at home and abroad.

This report was undertaken by Sir Bernhard Samuelson in 1867 at the request of the vice-president of the Committee of Council, and for the purpose of obtaining particulars he visited the principal manufacturing centres of Great Britain and the Continent. The report was published as a Parliamentary paper, and the *Times* records that it was for years referred to in all debates on technical education. He followed up this report by a Parliamentary inquiry into the education of the workmen of our manufactories in 1868, and was chairman of the committee, the report of which was adopted by the House of Commons. He was a member of the Duke of Devonshire's Royal Commission on Scientific Instruction, which issued a valuable report, and also of the Royal Commission on Elementary Education, presided over by Viscount Cross.

Sir Bernhard Samuelson was appointed chairman of the Royal Commission on Technical Instruction, the labours of which extended over the years 1882, 1883, and 1884, and embraced an examination into the systems in use in all parts of the United Kingdom and a great portion of the Continent of Europe. The exhaustive report of the Commission has become the standard authority upon the questions with which it deals. In 1888 he was appointed a member of the Parliamentary Committee for inquiring into the working of the Education Acts.

For his scientific work, Sir Bernhard Samuelson was elected a Fellow of the Royal Society in 1881, and for his many public services he was created a baronet in 1884, and was afterwards made a Privy Councillor. He was a member of the Institutions of Civil and Mechanical Engineers, and was the recipient, in 1871, of the Telford gold medal for a paper on improvements in iron manufactures. He was a member of the council of the Iron and Steel Institute, of which he occupied the presidential chair for two years. At the annual meeting of the institute held last week, the following resolution was unanimously adopted:—

"The council have received with the deepest regret the intimation of the death of their esteemed colleague the Right Hon. Sir Bernhard Samuelson, Bart., past-president, P.C., and one of the founders of the institute, and they desire to convey to Lady Samuelson and his family an expression of sincere sympathy in their bereavement. The council feel that it would be difficult to over-rate the services that Sir Bernhard rendered to the Iron and Steel Institute in the promotion of the objects for which it was formed, and they will ever remember with gratitude his constant readiness to devote his time and energies to the advancement of those objects."

DR. OTTO VON STRUVE.

THE announcement of the death of Dr. Otto von Struve does more than awaken a profound regret. His name recalls a period of past history, and summons up before us the memory of times when astronomy occupied a different position from that it assumes today, when it had fewer objects of interest wherewith to attract, and offered fewer problems for solution. Fifty-five years have gone since Otto von Struve received at the hands of the late Astronomer Royal the medal of the Royal Astronomical Society for his paper on precession and solar motion, and sixty-five since the paper was published. Seeing that Struve was born in 1819, he early came into prominence as an astronomer, and the value attached to the results and the confidence inspired by the paper are not a little remarkable, for there were some very obvious objections which might have been taken to the conclusions stated, or at least it appears so when viewed from a later standpoint. Accompanying the paper was also a discussion of the amount and direction of the solar motion. Only four years had elapsed since Argelander had published his paper assigning with some precision the place of the solar apex, and thus perhaps settling a doubt which had long divided astronomical thought. Prevost and Klugel had taken one side of the question, and Burckhardt and Lindenau led the party who were unwilling to accept the evidence. Men's minds were certainly divided as to the possibility of detecting the sun's motion, and Struve's paper came at a fortunate moment and strengthened the evidence produced by Argelander, for, based on very different material, Struve's position scarcely differed two degrees from that assigned by the Abo astronomer. Also, Struve was fairly fortunate in fixing the annual amount of the solar motion at about twice that of the radius of the earth's orbit. Later investigations have shown that a greater velocity is probable, but he was certainly correct in asserting that the linear motion of the sun appeared to be less than that of stars in general.

But it was in the domain of double stars that Otto von Struve won his reputation, and it was in this direction that he exhibited untiring industry. His father at Dorpat, and later at Pulkova, had not only devoted himself with great energy to this branch of astronomy, but had introduced a degree of accuracy into the observations that up to his time had been wanting. Otto von Struve, anxious to uphold the family reputation, was as diligent to detect these objects and as accurate in his observations as was his father before him, though he laboured under some peculiar difficulty as an observer, and was obliged to remove a systematic error which affected his observations by introducing a correction depending upon the distance of the component stars—a correction investigated with great care by means of artificial double stars.

From 1861, on the failing health of his father, Otto von Struve became the director of the Imperial Observatory at Pulkova, and in every department maintained the reputation for accuracy the observatory had won. In meridian places of stars, in cometary observations, in geodesy, in spectroscopy, the activity and efficiency of the institution have been everywhere acknowledged. In expeditions, whether for the transit of Venus or for eclipse work, the observatory has displayed its zeal and its desire to cooperate with similar work carried on elsewhere. Instruments have been renewed as needed, and the erection of the 30-inch refractor testifies to the determination to keep the observatory on a level with those best equipped. Under the care of the late director, splendid laboratories have arisen devoted to spectroscopic inquiries, and it is not too much to say that his direction of a world-famous observatory has been of a most enlightened and beneficent character. The recipient of many honours, he retired from the observatory in 1893 to enjoy the repose to which he was so well entitled amid the society of his many friends.

NOTES.

THE Croonian lecture of the Royal Society will be delivered by Mr. W. B. Hardy, F.R.S., on Thursday next, May 25, on "The Globulins."

BY the creation of the Committee of Defence, the functions and views of which were described by Mr. Balfour in the House of Commons on Thursday last, an expert advisory body has been introduced into the councils of the Government. In the discussion which followed the speech of the Prime Minister, Mr. Haldane remarked that millions of money uselessly expended would have been saved to the

country if such a committee had existed years ago. The idea underlying the formation of the committee is that for the handling of great national problems the Government must have expert assistance on a scale departmental inquiry cannot supply. Mr. Haldane suggested that it would be to the advantage of the nation if the principle of consultative committees were applied to the scientific organisation of the whole of our executive Government. "We shall never get the best service for the State until we cease to assign it merely to departments, until we can find some body to which it can be assigned that will be working under the head of the State himself. The work of the Committee of Defence illustrates the application of a new principle which will be a very familiar one before the country is much older."

THE Jacksonian prize of the Royal College of Surgeons of England has been presented to Mr. Herbert J. Paterson.

THE Elisha Kent Kane medal of the Geographical Society of Philadelphia has been awarded to Prof. William B. Scott, of Princeton University.

THE seventy-seventh annual meeting of the Society of German Naturalists and Physicians will be held this year at Meran on September 24–30.

THE Prince of Wales, as honorary president of the Royal Statistical Society, has consented to attend the opening meeting of the tenth session of the International Statistical Institute, which is to be held this summer in London.

THE Hanbury gold medal of the Pharmaceutical Society has this year been awarded to Prof. Ernst Schmidt, professor of pharmaceutical chemistry to the University of Marburg. This medal is awarded biennially for high excellence in the prosecution or promotion of original research in the chemistry and natural history of drugs, and Prof. Schmidt is the thirteenth man of science to whom the medal has been awarded. He is the first to receive, with the medal, the sum of 50*l*., which is presented to the medallist by Sir Thomas Hanbury, K.C.V.O.

WE have been requested by the council of the Society of Arts to give publicity to the following resolution passed at a meeting held on May 8:—"In view of the feeling which appears to have been aroused amongst some of the proprietors of the London Institution with regard to the proposed amalgamation with the Society of Arts, and the consequent probable difficulties of effecting a harmonious fusion of the two corporations into a single institution, the council of the Society of Arts have decided not to take any further action in the matter, and hereby discharge the committee which, at the instance of the board of managers of the London Institution, they appointed to consider the scheme for amalgamation."

THE programme has been issued of the optical convention to be held at the Northampton Institute, Clerkenwell, E.C., from May 30 to June 3, under the presidency of Dr. R. T. Glazebrook, F.R.S., director of the National Physical Laboratory. The list of papers to be read and discussed includes many of great scientific interest and practical value. Among the subjects and authors we notice:—the spectroscope in astronomy, Mr. H. F. Newall, F.R.S.; spectroscopic optics, Prof. Schuster; polishing of glass surfaces, Lord Rayleigh; parallel plate micrometer, Prof. Poynting; early history of telephotography, Major-General Waterhouse; tri-colour photography, Mr. A. J. Bull; and some directions of progress in optical glass, Mr. W. Rosenhain. The opening ceremony, presidential address, and conversazione will be held on Tuesday, May 30. A special lecture will be given by Prof. S. P. Thompson on "The Polarisation of Light by Nicol Prisms and their Modern Equivalents" on Thursday, June 1.

ON May 20 Dr. J. G. Frazer will deliver at the Royal Institution the first of two lectures on "The Evolution of the Kingship in Early Society," and on Thursday, May 25, Prof. J. A. Fleming will deliver the first of three lectures on "Electromagnetic Waves." These are the Tyndall lectures. On Saturday, June 3, Mr. A. H. Savage Landor will begin a course of two lectures on "Exploration in the Philippines." The Friday evening discourse on May 26 will be delivered by Prof. J. W. Brühl on "The Development of Spectrochemistry," on June 2 by Mr. George Henschel on "Personal Recollections of Johannes Brahms," and on June 9 by Sir William H. White on "Submarine Navigation."

THE *Times* announces the death of Lieut.-Colonel L. H. L. Irby at sixty-nine years of age. Throughout his life Colonel Irby took an intense interest in all branches of natural history, ornithology being his favourite subject. In 1875 he published a work on the "Ornithology of the Straits of Gibraltar" (south-west Andalucia and northern Morocco), a second edition of which appeared in 1894; and in 1887 appeared his "Key List of British Birds," which has proved to be of great utility to all lovers of birds. He was for many years a member of the council of the Zoological Society. He assisted in the formation of the life groups at the British Museum (Natural History), and some of the most remarkable of the cases of British birds there bear his name.

THE deaths are announced of M. Fernet, general honorary inspector of public instruction, and Prof. Victor René Muller, of Le Puy, both physicists.

OF the many valuable instruments bequeathed to the French Physical Society by the late M. Félix Worms de Romilly, the most interesting is the telescope bearing on the glass of its mirror the signature of M. Foucault. An account of this historic instrument is given by M. Cotton in the Bulletin of the French Physical Society (No. 226). The mirror has a diameter of 15·2 cm. and a focal length of 68 cm., giving a numerical aperture of about $f/4{\cdot}5$. The resolving power is 200,000, giving an angular separation of 1″. This is the only instrument constructed by Foucault with such a large aperture, and it is to be placed in the Paris Observatory after being re-silvered and adjusted by M. Cotton.

A BANQUET in aid of the funds of the London School of Tropical Medicine took place at the Hotel Cecil on May 10. Mr. Chamberlain, who presided, in proposing "The London School of Tropical Medicine," said he could not conceive of any subject of scientific research and philanthropic enterprise which was more interesting than tropical diseases, and it was a duty which we owed to the Empire, a duty which had increased in recent years with the continual extension of our territory. He thought we owed first to Sir Patrick Manson the idea of a tropical school. Almost abreast of him, if not before, came the promoters of the Liverpool School. There was room for all in this work, and they congratulated the Liverpool School on the success it had achieved. There was only one thing he envied them, and that was the liberality and energy of their citizens. He wished that in every other institution they could have a man as energetic, as devoted as Sir Alfred Jones. The London School now had accommodation for 40 students, and since its foundation six years ago 503

students had passed through it. They had to thank Sir John Craggs for founding a scholarship and prize, and Mr. Bomanji Petit, a Parsee gentleman, for a contribution of 700*l*. The committee now asked for the sum of 100,000*l*. for endowment, which amount was a mere drop in the bucket in comparison with the Liverpool subscriptions. The other speakers were Sir P. Manson, Mr. Alfred Lyttelton, M.P., Lord Strathcona, and the Duke of Marlborough, and among the 400 guests were Lord Rothschild, Sir Douglas Powell, Sir T. Barlow, the Hon. Sydney Holland, Sir Alfred Jones, Prof. Blanchard, Prof. Dunstan, the Hon. John Cockburn, Major Ronald Ross, Sir A. W. Rücker, Mr. Jonathan Hutchinson, Sir W. S. Church, and Mr. Watson Cheyne. Subscriptions and donations to the amount of more than 10,000*l*. were received.

THE visit of the French doctors to London last summer was so successful that a return visit of their British *confrères* to Paris was arranged, and the party arrived on May 10. The proceedings commenced with an evening reception at the Sorbonne. M. Ziard, president of the university council, and Dr. Bouchard, Sir William Broadbent, chairman of the London executive committee, Prof. Clifford Allbutt, of Cambridge, and Dr. George Ogilvie, senior physician to the French Hospital, London, exchanged mutually congratulatory speeches. The extensive and beautiful university buildings were thrown open, and were much admired. On Saturday the visitors attended a reception at the Pasteur Institute. Dr. Roux, the director of the establishment, welcomed the visitors in a short speech, in which he recalled the great services rendered to Pasteur by Lister. In the crypt of the institute, the dean of the medical faculty of the University of London, Dr. J. K. Fowler, laid a wreath upon Pasteur's tomb bearing the following inscription:—"A ce grand Pasteur, le bienfaiteur de la race humaine." In the course of his address Dr. Fowler is reported by the Paris correspondent of the *Times* to have said:—"We desire to offer a tribute of our profound admiration for the great Frenchman whose noble life and example will ever be an inspiration to those who, like him, are devoted to the cause of science. The discoveries of Pasteur alone would suffice to give the nineteenth century a preeminent place in the annals of science. Science knows no frontiers; it unites in a common brotherhood all who devote their lives to its service. Those who humbly follow, no matter at how great a distance, in the footsteps of Pasteur help to unite the peoples of the world. We are convinced that the friendship between France and Great Britain will ever continue to increase in cordiality, and that the two nations will work in accord for the advancement of science and will only strive for the attainment of one noble aim, the peace of the world." On Saturday evening a banquet was held under the presidency of Prof. Bouchard, who, after reading a congratulatory telegram from M. Loubet, announced that he had received from the President of the Republic the mission to bestow upon Sir William Broadbent the insignia of the rank of Commander of the Legion of Honour.

A REUTER telegram from Berlin reports that in the course of excavations in the neighbourhood of Breslau 400 graves and 150 prehistoric dwelling places were brought to light. The oldest of the graves contained bones dating from a period previous to the Bronze age, and in another grave near by were found urns showing that they had contained bodies interred five centuries later. The excavators have been able to trace the site of a village of the Bronze age. About a dozen huts are clearly recognisable. A whole collection of spinning and weaving appliances has also been dug up.

PROF. F. A. FOREL, writing from Morges, directs our attention to an earthquake which occurred on April 29 last. The centre of the seismic disturbance appears to have been in the neighbourhood of Martigny, Argentière, and Chamonix, and its intensity at the centre was viii. on the Rossi-Forel scale. The time of the principal shock was April 29, 1h. 45m. Greenwich time. The seismic area was of 250 kilometres radius, and included 200,000 square kilometres, comprising Valais, western, central, and eastern Switzerland, upper Italy, and western France. Further shocks were experienced at Martigny and Chamonix on May 1 at 19h. 22m. and 21h. 53m.; on May 2 the movements were very slight, and on May 6 a shock occurred at 4h. 45m.

REUTER'S Agency is informed that Mr. W. Champ, the leader of the expedition which is being dispatched to Franz Josef Land to rescue the twenty-six American explorers who have been in the Arctic for the past two winters with their ship, the *America*, left England on Saturday for Bergen. He was accompanied to Norway by Dr. Oliver L. Fassig, who has been dispatched by the United States Weather Bureau and the National Geographic Society of Washington to be their representative on the second relief ship, which will be dispatched from Norway to the east coast of Greenland. The main relief expedition, of which Mr. Champ is in command, will leave Tromsö in about a fortnight on board the *Terra Nova*, and will make straight for Capé Flora, Franz Josef Land, where it is expected that records will be found, and probably also some of the explorers who, under Mr. Fiala, the leader of the expedition, have been cut off from all communication with the outside world since July, 1903.

MESSRS. FRIEDLÄNDER AND SON, of Berlin, have sent us a copy of a catalogue of books and pamphlets dealing with the anatomy and physiology of invertebrates.

To the April issue of our Scandinavian namesake, *Naturen*, Dr. H. Magnus contributes the final instalment of his account of South Polar expeditions.

THE birds of the Isle of Pines (about 60 miles south of Cuba), by Messrs. Bangs and Zappey, and the fifth instalment of Dr. B. M. Davis's studies on the plant-cell, constitute the contents of the April number of the *American Naturalist*.

No. 3 of the "Cold Spring Harbour Monographs," by Miss Smallwood, is devoted to the Salt-Marsh amphipod *Orchestia palustris*, a species showing more decidedly terrestrial habits than its immediate relatives, and therefore, presumably, a more specialised type.

THE two plates issued in No. 3 of vol. xxv. of *Notes from the Leyden Museum* illustrate papers on molluscs. In the first of these Mr. M. M. Schepman describes a new species of Trochus from the Indian Ocean, and the adult condition of *Bathybembix aeola*, a Japanese form originally described from an immature specimen collected during the voyage of the *Challenger*. In the second Dr. H. F. Nierstrasz reviews the collection of chitons in the Leyden Museum, describing new species.

THE hereditary relations of plants to the diurnal and seasonal periods of their environment form the subject of an instructive article by Dr. R. Semon in *Biologisches Centralblatt* of April 15. In the same issue Dr. Wasmann

continues the account of his researches into the development of slavery among ants. It is interesting to note that the various local races of the widely distributed *Polyergus rufescens* respectively possess different types of slave-ants, which are for the most part subspecies of *Formica fusca*, although in one case the enslaved species is *F. nitidiventris*.

In connection with the latter part of the preceding paragraph, it may be mentioned that the April number of *Himmel und Erde* (Berlin) contains an illustrated popular account of the "flower-gardens" made by ants in the crowns of trees in Amazonia and Peru, as discovered and described by Mr. E. Ule. These "gardens," or perhaps we might rather say "baskets," are shown in various stages of growth, from the time when the plants are just budding until the long slender leaves of *Streptocalyx angustifolius*, which appears to be the favourite species, are fully developed. All the plants cultivated appear to have very minute seeds, or spores, which seem to be sown by the ants in their nests.

Mr. L. M. Lambe has sent us a copy of a paper by himself from the *Ottawa Naturalist* (vol. xix., part i.) on a large new species of sponge of the genus Esperella from the Pacific coast of Canada. We have also received a pamphlet on the life-history of the pear-midge (*Diplosis pyrivora*), by Mr. W. E. Collinge, published by Cornish Brothers, Ltd., Birmingham, as No. 2 of "Reports on Economic Zoology." It contains good figures of the various stages of the development of this pernicious insect, showing the manner in which it destroys young pears.

Among other articles in *Naturwissenschaftliche Wochenschrift* for April 30 is one by Dr. J. Meisenheimer summarising the results of recent investigations with regard to the origin and formation of pearls. Several illustrations indicate the positions in which pearls are usually found in shell-fish, while others show their internal structure, and others, again, the parasites usually constituting the nucleus. The researches of Mr. H. L. Jameson and of Messrs. Herdman and Hornell form the basis of a large portion of the paper.

It has been repeatedly noticed that when a pair of rooks attempt to build apart from the rest in a tree previously unoccupied, the other members of the colony not unfrequently set to work to destroy the nest. An event of this nature is recorded in the *Craven Herald* of April 28 as having taken place in the churchyard of Christ Church, Skipton. In this instance a pair of rooks had built in a tree overhanging Cross Street, and the female was incubating her eggs. While thus engaged she was attacked by the other rooks, who pecked her to death, throwing the body, together with the broken eggs and the ruined nest, to the ground. The attack was witnessed by many persons.

According to Mr. E. E. Green, in the March number of *Spolia Zeylanica*, the elephant-mosquito (*Toxorhynchites immisericors*) differs from Anopheles and many other members of the gnat family in that the larva is carnivorous. This carnivorous habit was suggested by the structure of the head of the larva, and observation showed that these larvæ prey upon one another as well as upon those of other gnats. In fact, but a single survivor was eventually left when a number of larvæ were placed in the same receptacle. In a second article Mr. A. J. Chalmers records the species of Anophelinæ found in Ceylon, while in a third Mr. H. Schoutenden contributes notes on Ceylonese aphides, with descriptions of new forms. Considerable interest attaches to a note by J. Hagenbeck in the same issue on an incubating python which safely brought off a number of young snakes.

In the *Zeitschrift für wissenschaftliche Zoologie*, vol. lxxix., part i., Mr. O. Schroeder, of Heidelberg, discusses the abdominal sense-organ, or so-called abdominal eye, of the palolo worm (*Eunice viridis*) of Samoa. This organ differs so widely from all definitely known types of eyes that it is difficult to find a basis of comparison. Indeed, whether it is an organ for the perception of light at all is extremely doubtful. The reasons that it has been regarded as such are the presence of nerve-cells, pigment, and a lens; but similar pigment is found in other parts of the creature's body, while the so-called lens would not come under the optician's definition of such an instrument. Pigment and lens-like structures are not unfrequently met with in luminous organs, but the so-called eye of the palolo worm certainly does not come under this category. In no other annelid has a similar organ been detected. The other articles in the same issue include one by Mr. P. Heinemann on the development of the mesoderm and the structure of the tail in the ascidian larva; a second, by Dr. M. Lass, on the histological anatomy of the female dog-flea; and a third, by Mr. A. Rufini, on the existence of an undescribed sheath in the terminal tract of human sensor nerves.

Prof. W. B. Benham, writing from the Otago University Museum, Dunedin, comments upon Dr. Alex. Hill's letter in our issue of February 2 on "Can Birds Smell?" Prof. Benham says that several points concerning the structure and habits of the kiwi suggest that its sense of smell is possibly highly developed. The nostrils, instead of being at the base of the beak, are at the extreme tip and on the under surface. The olfactory sacs, with their complex of turbinals, extend so far back as to project into the orbits, the eyes being separated by them instead of by a thin bony interorbital septum. The eyes of the bird are small and inefficient, notwithstanding its nocturnal habits, and observers state that the kiwi seeks its food by its sense of smell or hearing. In searching for food, the bird thrusts its beak into moss, piles of leaves, or into holes in the ground, and assumes an attitude suggestive of trying to obtain evidence of the presence of food either by smell or by listening for the sound of movements made by a worm in its burrow. These statements suggest the probability of a well developed sense of smell by the kiwi, and Prof. Benham hopes to have experiments carried out on the apteryx, oxydromus, and stringops in order to obtain evidence upon the matter.

The *Century Magazine* for May contains articles by Mr. Brush on the evolution of the arc electric light, by Mr. Holland on the recently discovered white bear of north-western British Columbia, and by Dr. McGee on the Japanese Army medical service. In the last named the organisation is described, particularly the arrangements in force for treating and transporting the large number of wounded from the seat of war, and the sanitary arrangements whereby typhoid and dysentery, the great scourges of armies in the field, are hardly known.

The April number of the *Bulletin of the Trinidad Botanical Department* contains articles on the phosphoric acid requirement of cacao plants, and on coffee curing for the small settler. The record of the visits paid by the two agricultural instructors to different districts and schools shows that their services are highly appreciated throughout the island.

THE fact is not generally known that species of the cycad Zamia can be artificially multiplied by cuttings. The subject of regeneration in Zamia is treated by Dr. J. M. Coulter and Mr. M. A. Chrysler in the *Botanical Gazette* (December, 1904). As a rule, new growth proceeds from meristematic tissue of the cork, but an instance is mentioned in which a portion consisting only of cortex gave rise to new shoots and root.

THE Department of Agriculture at Nairobi has instituted a series of leaflets which should be most useful to settlers in British East Africa. The first, issued in January, gives the native names in different dialects for the principal crops. A second provides some useful hints for cotton cultivators. Egyptian seed is recommended in preference to Sea Island or upland American, because, so far as experience goes, it has produced heavier crops, and also because it has been less affected by unfavourable conditions of the weather.

WE have received vol. xxvii. of *Aus dem Archiv der deutschen Seewarte,* for the year 1904. This valuable work, like its predecessors, contains some important discussions of meteorological and kindred subjects by well known men of science. One by Dr. W. J. van Bebber, entitled "Barometer and Weather," is of especial interest to meteorologists. He discusses, with reference to Hamburg more particularly, the relations of barometrical conditions to rainfall, temperature, and weather generally for the year, seasons, and months, for a period of twenty-five years. On this subject he brings to bear the special knowledge obtained as chief for many years of the Hamburg weather forecast department.

THE Meteorological Office has issued a circular stating that it will, as before, supply forecasts of weather by telegraph to agriculturists during the coming harvest season, at the cost of telegraphy only. These forecasts are prepared each afternoon from June 1 to September 30, except Sundays; but in view of the suspension of agricultural work on that day the office will, if required, transmit special forecasts on Saturday evening, giving, in very general terms, the prospects of the weather for the ensuing forty-eight hours. In the last published annual report of the office it is stated that many of the recipients of these forecasts keep a record of the weather experienced during the time the forecasts are sent, and return them to the office for the purpose of checking the results. From this comparison it appears that about 50 per cent. of the telegrams were completely successful.

MESSRS. CARL ZEISS, of Jena, have issued a new catalogue (in English) of their photomicrographic outfit for use with ultra-violet light of wave-length 0·275 μ, in addition to several catalogues of new ordinary microscope stands. The whole of the glasses—eye-piece, objective, slips and cover glasses—are of fused quartz, and the source of light is supplied by the current of sparks of a Leyden jar between cadmium electrodes. We notice one correction—dissolving power should be resolving power.

AMSLER'S planimeter is so well known to mathematicians that there is no need to direct their attention to its usefulness. We have, however, just received a small pamphlet by Mr. William Codd (London: E. and F. N. Spon) entitled "Land Area Computation made Easy," the object of which is to show non-mathematical readers how simple is the process of computing areas from maps or plans with this instrument. Mr. Codd has also, we learn, published "land area tables" to facilitate reduction to acres, roods, and perches, thereby saving the tedious calculations which are unnecessary in countries using the metric system.

A SERIES of observations on respiration at high altitudes is described by Prof. Angelo Mosso in the *Atti dei Lincei,* xiv. (1) 6. A special feature of these observations is the effect of carbon dioxide as a remedy for mountain sickness, a property regarding which experiments performed both on human subjects and on monkeys have led to most conclusive results in Prof. Mosso's hands. It is recommended that about 8 per cent. of carbon dioxide should be added to the compressed oxygen carried for use in high balloon ascents, as pure oxygen is not in itself sufficient to remedy the effects of great barometric depressions.

IN the *Transactions of the Institution of Engineers and Shipbuilders in Scotland* (xviii., 5), Mr. John Riekie discusses the various systems of compound locomotive engines, and describes a new form with which he has experimented. In it there are two equal high-pressure cylinders and one low-pressure cylinder of about $1\frac{1}{4}$ times the volume of the combined pair. It appears to differ from the well known "Webb" compound in that the crank-rods are all connected to a single three-throw crank set at angles of 120°, instead of working on the cranks of the axles of the two different driving pairs. It requires no special starting gear.

THE *Atti* of the Lincei Academy (xiv., 4) contains the announcement of the foundation by the King of Italy of a new international institution of agricultural studies. Among the advantages likely to accrue from the establishment of such an institution, the advancement of our knowledge of the best methods of combating against plant-diseases is specially mentioned. On this latter branch of study an interesting paper occurs in the same number of the *Atti,* by Dr. Vittorio Peglion, on the pathology of *Euonymus japonica.* This shrub, so common in Italian gardens, has been for many years subject to diseases, traceable in the first place to a scale insect, and in the second to a species of Oidium described by Saccardo and Arcangeli under the name of *Oidium evonymi-japonicae,* with which the present paper deals.

FROM a copy of the *Corriere di Catania* received from the Observatory of Catania, we gather some interesting particulars of the sudden eruption of Stromboli which took place about four weeks ago. On April 16, at about 2.9 p.m., a tremendous explosion as of a big cannon was heard, and the whole of the eruptive portion was enveloped in a dense black smoke. A large number of masses about one metre in diameter, and other smaller ones, were projected to a distance of 200 metres, and rolled down the Sciara del Fuoco to the sea, raising clouds of dust in their descent. Four or five minutes later there was a fall of scoriæ, about 5 cm. in diameter, over an area 4 kilometres long and 400 metres broad running E.N.E. of the volcano, in which direction the wind was blowing. A shower of ashes followed, and a quarter of an hour later a slight shower of rain occurred. At the time of the eruption Dr. Schulze was 300 metres to the south of the eruptive cone, where he was wounded in the head and leg by falling stones, fortunately not seriously. According to him, the opening by which this explosion took place is in the centre of the six others; it is known as No. 4. A considerable panic occurred throughout the island, and many of the inhabitants declare that such an eruption has never been witnessed before.

IN the Journal of the Russian Physical and Chemical Society (1904, No. 4) we notice the following papers:—An elaborate sketch and scientific analysis of the work, in organic chemistry, of Prof. Egor Egorovitch Wagner, by

V. V. Lavroff, followed by a full bibliographical index.—Determination of the inner energy of the gas-liquid systems, by A. N. Tschoukareff, with a *résumé* in French. By sealing various liquids in steel "sparklets," capable of supporting considerable inner pressures, the author could thus bring these liquids to high temperatures, above the critical temperature, and thus determine the specific heat of these substances in the critical state.—On the theory of the singing Voltaic arc, a mathematical inquiry by S. Maysel, which brings the author to conclusions opposed to those of Duddell, Janet, and Granqvist.

Messrs. Macmillan and Bowes, Cambridge, will publish in a few days a small book on "Mendelism," by Mr. R. C. Punnett, Cambridge. The volume will give an outline of Mendel's work on heredity, and its recent developments.

In the notice of Dr. D. Murray's volumes on "Museums" in our issue of April 13 (p. 554), the reviewer referred to the list of museums in the United Kingdom given in the work as being based on one prepared by the Museums Association. Mr. E. Howarth writes to point out that the list was a reprint of one prepared by a committee of the British Association in 1887, and not by the Museums Association, which did not commence the preparation of a museums directory until 1902.

Messrs. George Bell and Sons have published the second part of the key to the "Elementary Algebra" of Messrs. W. M. Baker and A. A. Bourne.

OUR ASTRONOMICAL COLUMN.

Orbit of Comet 1905 *a*.—A graphical representation of the orbit of comet 1905 *a*, according to the elements computed by Miss Lamson, of the U.S. Naval Observatory, is given in No. 5, vol. xiii., of *Popular Astronomy*. From this it is seen that the comet, at its perihelion, passed within 12,000,000 miles of the earth, but the latter body had, about a month before, passed the point where closest proximity was possible. The comet will continue, therefore, to grow fainter, and on May 30, according to Miss Lamson's ephemeris, it will be only 0·3 as bright as when first discovered, and it was only a faint telescopic object then.

Provisional Elements for Jupiter's Sixth Satellite.—Whilst awaiting more definite information from Lick, Mr. Crommelin has computed provisional elements for Jupiter's sixth satellite from the data already available. These data are not sufficient to decide the eccentricity of the orbit, so a circular form has been assumed. Although the Lick observers have now stated definitely that the "retrograde" in their first telegram did *not* refer to the orbital motion, the observations yet made have not settled the question of direction, and Mr. Crommelin has therefore computed elements both for "direct" and "retrograde." He finds the distance from the parent planet to be about 6,200,000 miles, and a comparison of this with the observational data favours a "direct" orbital motion, although, of course, much uncertainty exists. The inclination of the satellite's to the planet's orbit is 23°·8 or 23°·9, according to whether the motion is "direct" or "retrograde," whilst the inclination of the orbit to Jupiter's equator is either 26° or 24°·7. This inclination is unusually large as compared with other satellite orbits in the solar system, and according to the reports so far received the orbit of the seventh satellite has a still larger inclination.

According to the "direct" hypothesis, the pole of the sixth satellite's orbit is only about 1°·5 from our own North Pole, so that the major axis will always point nearly due east and west. A determination of the position angle next July, when it again reaches western elongation, should decide the question of the satellite's motion. The semi-minor axis of the apparent ellipse on December 25 (W. elongation) was 4′·96, and from this it is deduced that the inclination of the orbit plane to the line of sight on that date was 5°·7 (*Monthly Notices*, vol. lxv., No. 5).

Winter Fireballs in 1905.—In No. 357 of the *Observatory* Mr. Denning summarises the accounts of fireball observations, during January and February, which have been forwarded to him. Quite an unusually large number of these objects were observed. One slow meteor seen on January 27 at 11h. 59m., and another seen on February 28d. 12h. 10m., were at least as bright as the full moon, whilst one on January 14 at 10h. 16m., which was brighter than Venus, was noted by one observer as being followed by a slight rumbling noise at an interval of $2\frac{1}{2}$ minutes. The probable radiant of this object was 119°+3°, and it travelled from a height of 60 miles to a height of 29 miles, along a path of about 55 miles, with a velocity of 15 miles per second. A meteor seen at 10h. 15m. on February 28 from a radiant at 220°+40° divided into two parts at disappearance, whilst the last named of the eighteen objects mentioned in Mr. Denning's report, seen at 9h. 10m. on March 18, swelled out and exploded three times with lightning-like flashes during its four seconds' flight.

Observations and Light-curves of Several Variable Stars.—In No. 4011 of the *Astronomische Nachrichten* Dr. L. Terkán, of the O-Gyalla Observatory, publishes the results of a series of observations, and some light-curves, of several important variable stars. The observations were made during 1904 with a Zollner photometer, and the results are compared with the various published elements of each object. The stars dealt with are S Sagittæ, T Vulpeculæ, δ Cephei, η Aquilæ, β Persei, and λ Tauri.

Observations of "D_3" in the Solar Spectrum.—In No. 4012 of the *Astronomische Nachrichten* Dr. H. Kreusler, of Berlin, records two observations in which he saw the helium line, D_3, as a dark line in the spectrum of the region about a sun-spot. The first observation was made between noon and 2 p.m. on June 12, 1904, the second on the following day, and on both days the faculæ surrounding the spot were exceptionally bright. Dr. Kreusler suggests that, as it was near a maximum epoch of solar activity when Prof. Young recorded a similar observation in 1870, this phenomenon may be a characteristic of sun-spot maxima.

Brightness of Jupiter's Satellites.—In an attempt to settle the question of the variability of Jupiter's four brightest satellites, Prof. Wendell, of Harvard, made a series of photometric comparisons of them with a polarising photometer attached to the 15-inch telescope. The satellites were compared, for brightness, among themselves, and a large number of "settings" was made in such a manner as to eliminate accidental errors. The order of brightness was always iii., i., ii., iv., and the results afford no evidence for any variability during the period over which the observations extended, viz. from J.D. 2416900 to J.D. 2416928 (Circular No. 95 of the Harvard College Observatory).

Variable Stars in the Small Magellanic Cloud.—Some time ago it was reported in these columns that Miss Leavitt had newly discovered 57 variable stars in the small Magellanic cloud. In order to provide material for a closer study of the light-curves of these objects, sixteen negatives were taken at Arequipa with the 24-inch Bruce telescope, with exposures varying from two to four hours each. When the plates arrived at Cambridge (U.S.A.) in January, Miss Leavitt was greatly surprised to find that in this same region there were hundreds of variables which had not been seen on the previous inferior plates. In Circular No. 96 of the Harvard College Observatory the number in each half-degree square of the region is given, and, including the 57 previously announced, there are 910 new variable stars in all. This means that within the limits of the clouds there is one variable to every 308 stars, whereas of the 40,000 stars in the surrounding region shown on the plates only one in 3300 is apparently a variable, although all have been examined with equal care.

During the examination of the plates it was found that a thirteenth magnitude star, the position of which for 1900·0 was R.A.=1h. 6m. 1s., dec.=−72° 45′·5, has a large proper motion amounting to +0·13s. in R.A., +0″·42 in dec., and 0″·73 in a great circle.

SANITATION IN THE TROPICS.[1]

PROF. BOYCE and Messrs. Evans and Clarke, of the Liverpool School of Tropical Medicine, recently returned from a journey to the west coast of Africa, the object of which was to study the present sanitary condition of, and anti-malarial measures practised at, Bathurst, Conakry, and Freetown, to investigate how far the teaching of Ross has there been accepted and acted upon, and if, as a consequence, the health of these communities has improved during the last four years. This report embodies the results of their observations, together with suggestions for the further development of tropical hygiene in the future.

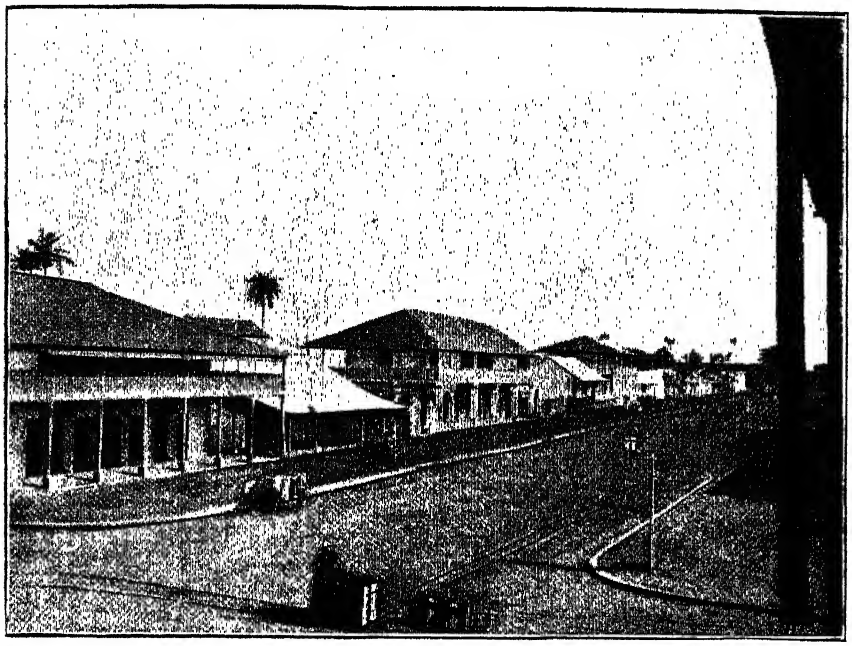

FIG. 1.—Principal Boulevard in Conakry, showing factories and Decauville rails. The main drain is under the footpath on the left.

At Bathurst sanitation is clearly of no low order, the town is well laid out, the streets are drained, and earth closets are the rule in the European quarters; but in the native compounds there are many cess-pits which tend to foul surface-wells, of which there are a number still in use, though there is a good public supply from deep wells. Anti-mosquito measures have been in force since 1902, consisting of the removal of old tins and rubbish, levelling and clearing of roads, examination of wells and water receptacles for larvæ, &c., and the more regular use of the mosquito net by Europeans. These precautions have made people think and be more careful, and the Europeans, it is stated, have been more free from malaria than formerly, but Culex mosquitoes still abound.

Conakry, in French Guinea, is a comparatively new town, well planned and laid out. There are no cess-pits of any kind, the pail system being in use, and a pure water supply is brought from watercourses 41 kilometres distant. In consequence, the private wells have fallen into disuse, but they have not been closed or filled up, and therefore serve as breeding grounds for mosquitoes. Anti-malarial measures do not seem to be carried out, mosquito nets are not made use of to any extent, and malaria is still very rife. The authors remark that (p. 20) "With model water supply under the control of the authorities, no streams, a good porous soil, and perfect sanitation mosquitoes should be got under control, and the freedom of the Europeans and of the natives from malaria guaranteed."

Freetown, in Sierra Leone, is not well laid out, and cess-pits are the rule. Of these there were 2650 in 1897, and their number has since increased, while more than 2000 of the inhabitants have no sanitary accommodation of any kind. The street drainage is still imperfect, and numerous opportunities exist for Anopheles mosquitoes to breed; but this condition of things is undergoing gradual improvement, and mosquito nets are in general use. The authors think that the health of the Europeans has in consequence improved, but evidently no striking result has yet been achieved. On the whole, we are disappointed that more definite results cannot be chronicled as the outcome of the health propaganda

FIG. 2.—A street in Freetown consisting of rock surface, in which there are innumerable pools breeding Anopheles (Rainy season).

so ably preached by the Liverpool School and its energetic staff, but obviously such success as has been attained should prove a stimulus for further effort, and not lead to any relaxation of present measures. The authors formulate a number of suggestions for the improvement of the health of the districts visited, of which the principal are:—(1) the

[1] "Report on the Sanitation and Anti-malarial Measures in Practice in Bathurst, Conakry, and Freetown." By Prof. Rubert Boyce, M.B., F.R.S., Arthur Evans, M.R.C.S., L.R.C.P., and H. Herbert Clarke, M.A., B.C. (Cantab.), Liverpool School of Tropical Medicine. Memoir xiv. (Liverpool: University Press. London: Williams and Norgate, 1905.)

instruction of newcomers in the part played by mosquitoes in conveying malaria, and in the habitual and proper use of mosquito nets; (2) the segregation of the native population away from the European quarters; (3) the total abolition of cess-pits; (4) the rational and systematic use of anti-malarial measures; (5) the public control of drinking water; and (6) the establishment of laboratories on the spot for the study of health problems. R. T. HEWLETT.

IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers on May 11 and 12, and was very largely attended. The report of the council, read by Mr. Bennett H. Brough, the secretary, shows that the institute continues to make satisfactory progress. The membership now amounts to 2000. The proceedings began with the adoption of a resolution of regret at the death of Sir Bernhard Samuelson, Bart., P.C., F.R.S., past president, referred to elsewhere (p. 61).

After the usual routine business, the retiring president, Mr. Andrew Carnegie, inducted into the chair the president-elect, Mr. R. A. Hadfield, whose first duty was to present the Bessemer gold medal to Prof. J. O. Arnold (Sheffield).

Mr. R. A. Hadfield then delivered his presidential address. It dealt chiefly with the history of metallurgy and with those branches of the subject to which his attention had been directed, more especially with the alloys of iron with other elements. He urged the necessity for constant research. In progressive manufacture, the complexity of which increases year by year, there is, in addition to the many ordinary difficulties met with, that of the solution of new problems which constantly present themselves. This can only be done by research, which should form an actual part of industrial operations, and demands almost as much attention as is devoted to the manufacturing side. It is more than ever necessary not to rest satisfied with the knowledge of to-day, or to think that this will satisfy the needs of to-morrow. Rapid and great changes are constantly occurring in metallurgy as in other branches of scientific knowledge. The thanks of the meeting for the address were expressed by Sir E. H. Carbutt and Sir William White, K.C.B.

Mr. S. Surzycki (Czenstochowa) submitted results obtained with the continuous open-hearth steel process as carried out in fixed furnaces in Poland. The process, which has proved eminently successful, is based on the principle of the Talbot process, with the essential difference that it can be carried out in any fixed furnace of not less than 25 tons capacity. The advantages do not consist solely in the continuity of the process, but in the longer life of the furnace, the higher production and yield, the lessened fuel consumption, and the simplicity of the plant.

A very elaborate paper was read by Mr. R. A. Hadfield, the president, describing some experiments relating to the effect produced by liquid-air temperatures on the properties of iron and its alloys. About eleven hundred specimens were tested. The bars, which were prepared with great care, were submitted to various heat treatments, the exact temperatures being recorded, and then forwarded to Sir James Dewar's laboratory at the Royal Institution. The tests were carried out on a small hydraulic testing machine, to which the necessary arrangements could be readily applied for immersing the specimens in liquid air. The results showed that, with certain exceptions, the effect of low temperatures is to increase in a remarkable degree the resistance of iron and iron alloys to tensile stress, and to reduce the ductility from the highest point to practically nil. The changes take place even in the softest wrought iron. The absence or presence of carbon in ordinary carbon steel in which other special elements are not present has little influence. Subjected to Brinell's hardness ball test, a specimen of Swedish charcoal iron at normal temperature had a hardness number of 90, whereas when tested at about $-182°$ C. this increased to no less than 266, or about equal to the hardness of 0·80 per cent. carbon steel at normal temperature. This almost seems incredible when it is remembered that this iron shows by analysis 99·82 per cent. of iron, and normally has only 20 to 22 tons tenacity with 25·30 per cent. elongation. This iron becomes brittle to an extraordinary degree under the influence of the low temperature $-182°$ C., whereas nickel tested at the same low temperature has improved rather than deteriorated, not only in tenacity, which iron also does, but in ductility, in which latter quality iron entirely breaks down. If nickel, therefore, is present in an iron alloy containing but little carbon or comparatively low in that element, it acts as a preventive of brittleness, or is a very considerable modifier of that objectionable quality. This action of nickel is simply marvellous in certain of the alloy specimens, for example, in the case of an alloy of iron, carbon 1·18 per cent., nickel 24·30 per cent., and manganese 6·05 per cent. Here the ductility is extraordinary at not only ordinary but low temperatures, probably the highest known for any iron alloy, and certainly for an alloy having such tenacity as 84 tons per square inch. There is still present in this alloy 68 per cent. of iron, yet the tendency of the latter metal to wander into the paths of brittleness is not only entirely checked at the liquid air temperature—and this brittleness, as shown so clearly in this research, occurs to an extraordinary extent in pure iron cooled to $-182°$ C.—but the elongation or ductility, already so great, is considerably increased, namely, from 60 per cent. to $67\frac{1}{2}$ per cent. There is also an increase of tenacity in both cases, namely, a rise of from 10 per cent. to 38 per cent. Thus the nickel present enables the bar under this high tension and at $-182°$ C. to remain far more ductile than the very best of ductile iron of one-third the tenacity. Although the action of nickel has been specially referred to, it must not be overlooked that in this alloy there is also present 6 per cent. of manganese, which in its ordinary combination with iron, that is, with no nickel present, would confer intense brittleness upon the iron and render it more brittle than if not present. This treble combination of nickel-manganese with iron appears to reverse all the known laws of iron alloys.

Mr. J. H. Darby (Brymbo) and Mr. George Hatton (Round Oak) summarised the recent developments in the Bertrand-Thiel process of steel manufacture. This process, which was first used in Bohemia in 1894, consists in carrying out the preliminary refining in an upper open-hearth furnace, and the steel-making is completed in a secondary open-hearth furnace. The original plan of having furnaces at different levels has not proved so satisfactory as having the furnaces arranged in line with a mixer at one end. Pig iron of almost any ordinary composition may be used. At Brymbo, with a highly phosphoric pig iron, seven 20-ton charges per day have been attained, and at the Hoesch works in Dortmund ten charges per day have been regularly produced.

At the New York meeting of the Iron and Steel Institute, the paper read by Mr. James Gayley on the application of the dry air blast created quite a sensation in the iron industry. Mr. Gayley now gives, in a supplementary paper, a record of operations of the Isabella furnaces at Pittsburg from November, 1904, to March, 1905, showing that the increased iron output and the decreased coke consumption derived from the use of dry air were well maintained.

The rapid development of the gas engine of recent years has given special value to the gas escaping from the blast furnace, previously often described as waste gas. The gas leaving the blast furnace carries with it a varying amount of gritty dust, which has proved a serious obstacle to the successful operation of large gas engines. The various methods of cleaning the gas were described in the paper submitted by Mr. Axel Sahlin, who has designed a slowly revolving apparatus for the purpose.

Dr. O. Boudouard (Paris) submitted a lengthy account of experiments made to determine the fusibility of blast-furnace slags. He gave a chart enabling metallurgists to determine the fusion temperature of a given alumino-calcic silicate. The information given in this lengthy paper is of great value, inasmuch as one of the most important considerations in the satisfactory running of a blast furnace is a knowledge of the degree of fusibility of the slag.

Mr. Sidney A. Houghton contributed a note on the failure of an iron plate through fatigue. The plate was

from the boiler of a portable engine about twenty years old. Microscopic examination showed that the effect of fatigue stresses on the plate had been to form cracks commencing as a rule from irregularities on the inner surface, which cracks were due to weakness in the cleavage planes of the crystals from continual slipping, and to a less degree to some loss of adhesion between the crystals. Some of the crystals appeared to have been broken up, and the slag flaws seemed to have a restraining effect on the progress of the cracks.

Mr. B. H. Thwaite (London) directed attention to accidents due to the asphyxiation of blast-furnace workmen, and described an apparatus for the rapid detection of the presence of carbon monoxide in air.

Prof. F. Wüst and Mr. F. Wolff (Aachen) submitted a paper on the behaviour of sulphur in the blast furnace. They showed that, contrary to the generally held opinion, the sulphur in the coke does not reach the level of the tuyeres of the blast furnace without undergoing alteration, but a great portion of it is previously volatilised by the ascending gases. It is then largely absorbed from the gases by the descending charge, and in this condition arrives in front of the tuyeres. Up to 800° the sulphur is principally absorbed by the oxides of iron from the sulphur-laden gases, while from 800° upwards the position is reversed, and the lime becomes the chief absorbent of the sulphur.

Reports of research work carried out during the past year by Dr. H. C. H. Carpenter (National Physical Laboratory), by Mr. J. C. Gardner (Birmingham), by Mr. F. Rogers (Cambridge), and by Mr. Gunnar Dillner and Mr. A. F. Enström (Stockholm), holders of the Carnegie research scholarships, were submitted. Dr. Carpenter dealt with the types of structure and the critical ranges on heating and cooling high-speed tool steels under varying thermal treatment.

In the light of the author's experiments the rationale of the advantageous presence of tungsten and molybdenum in high-speed tool steels appears fairly evident. The action of either of these elements consists in hindering, under certain conditions, and in altogether preventing, under suitably chosen conditions, changes in iron carbon alloys which would have for their result the softening of the material and its consequent unfitness for tool steel use. By suitable heat treatment it is possible to arrest the softening process at any desired stage, and thus obtain an alloy of any desired hardness. The metallographical results of the investigation are extremely interesting. They show that in spite of comparatively large percentages —up to 17 per cent. or 18 per cent.—of special elements, iron and carbon still remain as the all-important factors in determining the types of structure of high-speed tool steels. Except that the polyhedral or "austenitic" type of structure has never been obtained alone in a pure carbon steel, the types of the high-speed tool steels might all be obtained from pure iron carbon steels by appropriate thermal treatment. The austenitic structure appears to be that of the nose of the tool in actual use. Put briefly, the hardening of rapid tool steels at the present time appears to involve two factors, viz. (1) the widening, splitting, or lowering of the critical ranges by the special alloy element, and (2) the complete, or practically complete, suppression of the widened, split, or lowered range by a mild quenching, *e.g.* in an air-blast.

Mr. G. Dillner and Mr. A. F. Enström dealt with the magnetic and electric properties of sheet steel and steel castings. The results obtained have rendered it possible to make some comparisons as to the relative suitability of the different methods for producing a soft steel for electrotechnical purposes (sheet material). It has appeared that Bessemer steel has a lower magnetic quality than open-hearth steel. On comparing basic and acid open-hearth steel, the basic steel has been found to be preferable and scarcely inferior to Lancashire iron. The reason why the Bessemer material is inferior in quality to the open-hearth sheets may possibly be that the Bessemer steel has a greater opportunity of dissolving gases when the air is passed through the bath of molten metal. In general, basic steel does not contain such large quantities of silicon and manganese as acid steel, and at the same time it is possible to get a lower percentage of carbon in the first mentioned metal; these facts may cause the hysteresis loss to be lower in basic than in acid steel.

Mr. J. C. Gardner dealt with the effects caused by the reversal of stresses in steel, and Mr. F. Rogers submitted memoirs on troostite and on the heat treatment of steel.

It was announced that Andrew Carnegie research scholarships for this year, of 50*l.* each, were awarded to P. Breuil (Paris), Dr. H. C. H. Carpenter (National Physical Laboratory), E. G. L. Roberts and E. A. Wraight (London), and W. Rosenhain (Birmingham), and that scholarships, each of the value of 100*l.*, were awarded to H. C. Boynton (Cambridge, U.S.A.), L. A. Guillet (Paris), and W. H. Hatfield (Sheffield).

The council carefully examined the reports of the research work carried out by the holders of the Carnegie research scholarships during the past year, and decided that the report prepared by Dr. H. C. H. Carpenter (National Physical Laboratory) was deserving of the gold medal. The council also decided that special silver medals should be awarded for the research carried out conjointly by Mr. Gunnar Dillner and Mr. A. F. Enström (Stockholm). The researches submitted by Mr. Gardner and Mr. Rogers were highly commended. The medals were presented by Mr. Carnegie at the banquet on May 12 at the Hotel Cecil, when 500 gentlemen were present.

During the meeting it was announced that Mr. Carnegie would give to the institute a further sum of 5000*l.* to cover the cost of printing the reports submitted by the Carnegie research scholars.

HIGHER EDUCATION IN LONDON.

RECENT events inspire hope in the future of higher education in London. The report presented by Sir Arthur Rücker, F.R.S., principal of the University of London, at the celebration of presentation day on May 10, and the speech of Lord Londonderry in proposing "The Institution of Mining and Metallurgy" at the annual dinner of its members, are both highly encouraging and indicative of the growing importance attached in the metropolis to education of university standing, especially in science and technology.

Sir Arthur Rücker, in the course of his report, dealt in detail with the operations of the University of London, and was able to show that some of the preliminary work done since the re-organisation of the university has begun to bear fruit in the academic year now approaching its termination, and that the activity of the university has been extended in several directions. The question of the conditions of entrance to universities has been prominently before the public during the year, and a very important step has been taken by the Universities of Oxford, Cambridge, and London, which have agreed upon a scheme for the mutual recognition of the certificates given for their respective entrance examinations. Already twenty-five persons have been matriculated as students of London University under this agreement. Considerable progress has been made, also, with the project for the concentration of the teaching of the preliminary and intermediate studies of medical students in a few centres under the control of the university. Arrangements are in progress under the auspices of the university for establishing centres at University and King's Colleges, and Mr. Alfred Beit has given a munificent donation of 25,000*l.* in aid of the scheme for the establishment of a third centre on the South Kensington site. It is much to be hoped that this generous gift will be supported by other large subscriptions. It is a matter of vital interest to the public that the unique opportunities for medical education afforded by the great metropolitan hospitals shall not be wasted, and, if they are to be utilised, it is essential that the whole curriculum of medical education shall be easily accessible to London. It is necessary, continued Sir Arthur Rücker, that medical education shall receive public help similar to that which is ungrudgingly given to engineering. It is not too much to say that medical men do more unpaid work for the public than do the members of any other profession, and that, in return, less help has been given by the public to medical education, in London at all events, than to any other of the principal branches of applied science. Large as the gifts to the university are,

it is unfortunately true that much money is needed to make up for the neglect of university teaching in London in the past. Though the increase in the Government grant to university colleges will be of great value, the equipment of both University and King's Colleges needs improvement, and the salaries of the professors are quite inadequate. The whole question of retiring pensions, to which a private donor has just devoted 2,000,000*l*. in America, is untouched in London.

After the presentation for degrees at the University of London, there was a reception at Bedford College. The occasion is always one for the assembling of the friends of the higher education of women in London, and about five hundred guests were received by the principal, Mrs. James Bryce, and Mrs. Leonard Darwin. The students who were presented at the university included eight for science degrees. The college authorities are contemplating a great re-building scheme, for the lease of the present premises in Baker Street is almost on the point of expiring, and an appeal is being made for a quarter of a million sterling, of which 100,000*l*. would be devoted to endowing a college capable of accommodating five hundred students.

Lord Londonderry, in his speech at the annual dinner of the Institution of Mining and Metallurgy, referred to the work of the committee appointed by the Government to consider the coordination of the Royal College of Science at South Kensington with other institutions for higher scientific and technological instruction in London. An interim report has been presented by the committee. The Government has definitely informed the committee that, provided satisfactory arrangements can be arrived at for the due coordination of the work of the various higher scientific teaching institutions in London and elsewhere, and provided that guarantees are obtained for the adequate management of what will practically be a congeries of highly organised technical courses, and for the provision of a thoroughly satisfactory annual income for the upkeep of a great centre for this higher work, the Government is prepared to entrust the management of the Royal College of Science, including the Royal School of Mines, to a committee to be newly established for the purpose. This procedure, it is expected, will bring the work of the Royal College and School of Mines into the closest possible relations with that of the other higher teaching institutions, so that a higher degree of cooperation and coordination may be attained in this important portion of the educational field. Lord Londonderry announced that he has good grounds for believing that the Chancellor of the Exchequer has been considering the financial aspect of the new condition of things that will be brought about in regard to the Royal College of Science if the changes outlined actually take effect, and that a reasonable increase in the sums at present annually devoted towards the expenses of the Royal College of Science will be made. Thus the Royal College, in its immensely enhanced possibilities of usefulness owing to its large new buildings, will be able to bring to the common aim, not only its fabric and its excellent equipment, and, of course, its good will and prestige, but also a satisfactory annual income as a substantial contribution to what must be the heavy annual expenditure involved in the great work to be carried on for higher scientific and technological education in the metropolis.

As Mr. Haldane, the chairman of the committee referred to by Lord Londonderry, said on the same occasion, there is now a prospect of the establishment of such a school of mining and metallurgy as will make London the first city of the Empire in point of education in these matters.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Some five or six years ago a special committee was called together at Cambridge, and an effort was made to obtain the cooperation of the colleges and the town and county councils in a scheme for the improvement of the milk supply of Cambridge. The committee had as its primary object the eradication of tuberculosis, beginning with bovine tuberculosis, from the county of Cambridge. Concurrently it took up the question of the housing of cattle, the sterilisation of milk, the methods of storage and distribution of milk, and the question of what milk should be refused by the colleges and by private purchasers. All these points were considered, not only with regard to tuberculosis, but also in connection with other infectious diseases, *e.g.* diphtheria, scarlet fever, and typhoid fever. The Cambridge Town Council undertook to pay the expenses of a veterinary surgeon, and the following colleges undertook to consider the matter favourably, and in most cases offered a certain annual subvention:—Gonville and Caius, Trinity Hall, King's, Christ's, Sidney, Emmanuel, Downing, and Girton, but the larger colleges stood out, and the scheme fell through.

Prof. Woodhead, in an interesting article in the *Cambridge Review* of last week, raises the question whether some such scheme should not be revived, and points to the recent outbreak of scarlet fever, which was especially prevalent in one or two colleges, as an instance of a disease which might easily have been avoided if the community had taken proper precautions.

It is proposed to erect a building containing examination rooms on a site on the north-east corner of the museum grounds. At present the university is put to great cost in hiring rooms which, apart from their expense, are not well adapted for examinations. The syndicate appointed to consider this question estimates that for a sum of 7500*l*. it could provide for all examinations held in the university throughout the year, except, perhaps, for a week or two in June and December.

The Vice-Chancellor announces the generous offer of the Drapers' Company to find the sum of 5000*l*. towards the cost of a building for the department of agriculture provided that a further sum of 5000*l*. is raised by voluntary subscriptions by the end of the current year.

The long vacation course in pathology, public health, and pharmacology will begin on Monday, July 3. Special courses of lectures have been arranged on phagocytosis, by Prof. Woodhead, with the assistance of Mr. W. Malden; on illness caused by unsound food, by Mr. H. E. Durham; on diphtheria, agglutinins, precipitins and hæmolysins, by Mr. G. S. Graham-Smith; and on protozoa and protozoal diseases, by Dr. Nuttall. Further information about these courses may be obtained by writing to Prof. Woodhead, The Museums, Cambridge.

Special courses on physiology, osteology, human anatomy, and histology will be given during the long vacation by Mr. Barcroft and Mr. Cole, Dr. Barclay-Smith, Dr. A. Hill, and Mr. Manners-Smith. These will begin on July 5.

THE jubilee of Cheltenham Ladies' College was celebrated on Saturday last, and a new science wing was declared open. The new laboratories and lecture-rooms have been erected at a cost of 18,000*l*., and include rooms well equipped for the teaching of physics, chemistry, and botany.

THE following resolution was carried at a meeting of the council of the Royal College of Surgeons of England, held on Thursday last:—"That it be referred to the Committee of Management to consider and report as to the desirability of treating chemistry, physics, and biology as subjects of preliminary education, and of requiring that an examination in them should be passed before the recognition of the commencement of medical studies, and to report further as to the desirability of the two colleges approaching the Universities and other examining bodies with the view of adopting a five years' curriculum of professional study from the date of passing the Preliminary Science Examination."

AN entrance scholarship in science, value 48*l*. for three years, will be awarded by the council of Bedford College for Women (University of London) on the result of an examination to be held June 28–30. Full particulars can be obtained from the principal, and forms of entry must be received by June 12. The council, on the recommendation of the Reid trustees, will award the Reid fellowship in June to a graduate of the University of London who is also an associate of Bedford College. Applications should

be received by the hon. secretary of the Reid trustees by May 30. Miss Alice Ravenhill is to begin a course of lectures on May 18, at 4.30 p.m., on the "Teaching of Hygiene."

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, May 4.—Prof. R. Meldola, F.R.S., president, in the chair.—Notes on sodium alum: J. M. **Wadmore**. The author has confirmed the observations of Augé, Zellner, and Dumont as to the existence and certain of the properties of sodium alum.—Camphoryl-*pseudo*-semicarbazide: M. O. **Forster** and H. E. **Fierz**. This compound was obtained by reducing camphorylnitroso-*pseudo*-carbamide with zinc dust in dilute acetic acid; it condenses readily with aldehydes and ketones, yielding products characterised by high specific rotatory powers.—Some derivatives of anhydracetonebenzil: F. R. **Japp** and J. **Knox**. Descriptions of the condensation products of benzil with certain unsaturated ketones are given.—The dihydrocyanides of benzil and phenanthraquinone, part ii.: F. R. **Japp** and J. **Knox**.—A condensation product of mandelonitrile: F. R. **Japp** and J. **Knox**. It is shown that Minovici's compound, $C_{16}H_{12}ON_2$ (*Ber.*, 1899, xxxii., 2206), obtained by saturating mandelonitrile in dry ether with hydrogen chloride, is identical with the substance obtained by Japp and Miller by the action of hydrogen chloride on a solution of benzil in alcoholic hydrocyanic acid (*Trans. Chem. Soc.*, 1887, li., 29).—Action of hydrazine on unsaturated γ-diketones: F. R. **Japp** and J. **Wood**. The authors have used Paal and Schulze's reaction to distinguish the configurations of certain analogous unsaturated diketones. By this means they have obtained confirmatory evidence for the configuration assigned by Japp and Klingemann to the two modifications of $\alpha\beta$-dibenzoylstyrene and of dibenzoylstilbene.—The synthesis of substances allied to adrenaline: H. D. **Dakin**.—Methylation of *p*-aminobenzoic acid by means of methyl sulphate: J. **Johnston**.—The atomic weight of nitrogen: R. W. **Gray**. By the examination of (1) the relative densities and compressibilities of nitric oxide and oxygen, and (2) the decomposition of nitric oxide with finely divided nickel, a mean value of 14·006 (which is regarded as possibly too low) was found for this constant.—The methylation of gallotannic acid: O. **Rosenheim**. A penta-methyl-derivative was obtained, by methylation with methyl sulphate, and this on hydrolysis furnished a mixture of trimethyl- and dimethyl-gallic acids.—The interaction of hydrogen sulphide and sulphur dioxide: W. R. **Lang** and C. **Carson**. An investigation of Wackenroder's solution showed that the action of hydrogen sulphide produces first sulphur and water, and that by the further action of sulphur dioxide on sulphur polythionic acids are produced.—The formula of cyanomaclurin: A. G. **Perkin**. It is now found that the formula $C_{15}H_{12}O_6$ is to be preferred in place of $C_{15}H_{14}O_6$ formerly used.

PARIS.

Academy of Sciences, May 8.—M. Troost in the chair.—The increase of the rotatory power of fatty molecules in passing to the state of cyclic compounds: A. **Haller** and M. **Desfontaines**. A comparison is given of the rotatory powers of alkyl esters of β-methyladipic acid with the esters of the corresponding β-cyclopentanonecarboxylic acids, the rotations of the latter being found to be about thirty times those of the former. The densities and boiling points of the various esters under examination are also given.—On a new synthesis of oxalic acid: H. **Moissan**. It has been shown in a previous paper that whilst perfectly dry carbonic acid is without any action upon potassium hydride, in the presence of a minute trace of water the two substances react with the quantitative formation of potassium formate. It is now shown that if this reaction is allowed to take place at a higher temperature, 80° C., a mixture of potassium formate and oxalate is produced. The oxalic acid formed was separated, and its identity proved by analysis and numerous reactions.—Endoglobular pseudo-hematozoa: A. **Laveran**. As some of the normal elements of blood, more or less modified in their appearance, have on more than one occasion been mistaken for endoglobular hematozoa, a detailed account, with diagrams, is given of some of the more common cases leading to this error.—On the magnetic hysteresis produced by an oscillating field superimposed on a constant field: P. **Duhem**. A theoretical investigation completing a former paper on the same subject.—Geodesic and magnetic work in the neighbourhood of Tananarive: P. **Colin**. The triangulation of the rectangular section between the south and west of Tananarive has been completed at sixty-seven points. At the same time magnetic observations have been carried out at twenty-six stations, a tabular view of the results being given.—The oscillations of railway carriages on entering and leaving a curve: Georges **Marié**.—Observations of the Giacobini comet (1905 *a*) made with the large equatorial of the Observatory of Bordeaux: Ernest **Esclangon**.—On Voss surfaces and non-Euclidean geometry: Alphonse **Demoulin**.—On the indeterminate equation $x^a+y^a=bz^a$: Ed. **Maillet**.—On some points in the theory of numbers and the theory of functions: Georges **Rémoundos**.—On a new spectrum observed in gadolinium: G. **Urbain**. The author, having obtained a specimen of gadolina of such purity that twenty successive fractions gave the same value for the atomic weight, has examined the spectrum. There is no absorption spectrum in the visible region, but there are some strong absorption lines in the ultra-violet. The ultra-violet phosphorescence given by this gadolinium in the kathode rays proved to be the same as that attributed by Sir W. Crookes in 1898 to a new element named by him victorium. The author proposes to submit the question as to the identity of gadolinium and victorium to further experiment.—On the triboluminescence of potassium sulphate: D. **Gernez**. The experiments of the author are not in accord with those of Bandrowski on the same subject. The emission of light appears to be the result of breaking up of crystals already formed, and if due precautions against shock be taken, the phenomenon is not observed at the moment of separation of the crystals from their mother liquor.—The specific volume of a liquid in a capillary space: M. **Ponsot**.—On the electrical resistance of metallic wires for high-frequency currents: André **Broca** and M. **Turchini**. The authors have compared the resistances obtained experimentally with those calculated from Lord Kelvin's formula. For non-magnetic metals, copper and platinum, the deviations from the law calculated by Lord Kelvin are small for moderate frequencies. These deviations, however, are greater than the experimental error, and follow a definite law.—A new method of calculating the exact molecular weights of liquefiable gases from the experimental determination of their densities: Philippe A. **Guye**. The method described, the detailed proof of which is reserved for a later paper, has been applied to the cases of carbon dioxide, nitrous oxide, sulphur dioxide, hydrochloric acid, and acetylene. The values for the atomic weights of carbon, hydrogen, sulphur, and chlorine agree very closely with those determined by chemical methods. The value for nitrogen (14·006) is lower than the value deduced from chemical data (14·04), and there is reason to suppose that the latter is too high.—The action of potassammonium upon barium bromide: A. **Joannis**. The reaction has been found to be in accordance with the equation

$$BaBr_2+2NH_3K=2KBr+H_2+Ba(NH_2)_2.$$

—On the colloidal forms of ferric chloride: G. **Malfitano**.—The electrolytic reduction of the nitrocinnamic acids: C. **Marie**. Meta- and para-nitrocinnamic acids give by electrolytic reduction in alkaline solution the corresponding azoxy acids. The position of the nitro or the amino group has a marked influence on the ease with which the hydrogen is added to the lateral chain. Para derivatives give hydrocinnamic compounds much more easily than the corresponding meta compounds.—The action of carbon monoxide upon silver oxide, and its application to the determination of small quantities of carbon monoxide in the atmosphere: Henri **Dejust**. Silver oxide, dissolved in ammonia, is immediately reduced by traces of carbon monoxide. The author proposes a colorimetric method based on this reaction for the estimation of minute traces of carbon monoxide in the air.—On strontium ammonium:

M. **Rœderer.** Strontium ammonium is prepared in a similar manner to the compounds of ammonia with barium and calcium, and has the analogous formula $Ba(NH_3)_6$.—Osmosis through tubes of fused quartz: G. **Belloc.** The passage of gases through quartz tubes appears to be the result of a kind of devitrification caused by moisture and high temperature, the tendency to crystallisation being clearly made out under the microscope.—On a new osmium compound and a new reaction for osmium: Piñerûa **Alvarez.** The process is based on the formation of a green compound of hydriodic acid and osmium iodide of great tinctorial power.—The action of alkalis on aqueous solutions of acetol: André **Kling.** The behaviour of acetol on neutralisation with bases seemed to point to its being a pseudo-acid, and this view was confirmed by a study of the changes in its electrical conductivity.—On the saccharification by malt of artificial starch: Eug. **Roux.**—The action of metal ammoniums on the halogen derivatives of methane: E. **Chablay.** The equation

$$2NH_3Na + 2CH_3Cl = 2NaCl + CH_4 + CH_3.NH_2 + NH_3$$

was found to represent the reaction between methyl chloride and sodium ammonium. The reactions with chloroform and iodoform were more complicated.—On the use of metal ammoniums in organic chemistry: the formation of primary amines: Paul **Lebeau.**—On a new method of characterising the purity of milk based on the estimation of the ammonia: A. **Trillat** and M. **Sauton.** Ammonia should not be present in normal pure milk; its presence is evidence of pollution.—On polymorphic transformations by mechanical action: Fred. **Wallerant.**—On the state of preservation of minerals in arable earth: M. **Cayeux.** In opposition to the views of MM. Delage and Lagatu, the author finds that minerals in an altered state are always present in arable earth.—New species of endophytes of orchids: Noël **Bernard.**—The culture of Morchella: Ch. **Répin.**—The elective action of chloroform on the liver: M. **Doyon** and J. **Billet.**—On the toxicity of the urinary alkaloids: H. **Guillemand** and P. **Vranceano.**—The estimation of the sugar in the blood at the moment of accouchement in the goat without udders: M. **Porcher.**—The influence of sexuality on the nutrition of *Bombix mori* at the later stages of its evolution. The localisation of the glycogen, fat, and soluble albumen in the course of nymphosis: C. **Vaney** and F. **Maignon.**

DIARY OF SOCIETIES.

THURSDAY, May 18.

Royal Society, at 4.30.—On Lesage's Theory of Gravitation and the Repulsion of Light: Prof G. H. Darwin, F.R.S.—The Atomic Weight of Chlorine; an Attempt to Determine the Equivalent of Chlorine by direct burning with Hydrogen: Prof. H. B. Dixon, F.R.S., and E. C. Edgar.—The Flow of the River Thames in Relation to British Pressure and Rainfall: Sir Norman Lockyer, K.C.B., F.R.S., and Dr. W. J. S. Lockyer.—Thorianite, a New Mineral, from Ceylon: Prof. W. R. Dunstan, F.R.S., and G. S. Blake.—A Modified Apparatus for the Measurement of Colour, and its Application to the Determination of the Colour Sensations: Sir William Abney, K.C.B., F.R.S.—Further Observations on the Germination of the Seed of the Castor Oil Plant (*Ricinus communis*): Prof. J. Reynolds Green, F.R.S., and H. Jackson.—On the Efferent Relationship of the Optic Thalamus and Deiter's Nucleus to the Spinal Cord, with Special Reference to the Cerebellar Influx Theory (Hughlings Jackson) and the Genesis of Decerebrate Rigidity (Sherrington): Dr. F. H. Thiele.—On Reciprocal Innervation of Antagonistic Muscles. Eighth Note: Prof. C. S. Sherrington, F.R.S.—The Structure and Function of Nerve Fibres. Preliminary Communication and Addendum: Prof. G. S. Macdonald.—On the Occurrence of *Anopheles* (*Myzomyia*) *Listoni* in Calcutta: Major A. Alcock, C.I.E., F.R.S., and Major J. R. Adie.—On the Chemical Mechanism of Gastric Secretion: Dr. J. S. Edkins.—Contributions to the Physiology of Mammalian Reproduction. Part I. The Œstrous Cycle in the Dog. Part II. The Ovary as an Organ of Internal Secretion: F. H. A. Marshall and W. A. Jolly.

Royal Institution, at 5.—Flame: Sir James Dewar, F.R.S.

Society of Arts, at 4.30.—Plague in India: Dr. C. Creighton.

Faraday Society, at 8.—An Application to Electrolytes of the Hydrate Theory of Solutions: Dr. T. M. Lowry.

FRIDAY, May 19.

Royal Institution, at 9.—The Native Races of the British East Africa Protectorate: Sir Charles Eliot, K.C.M.G.

Epidemiological Society, at 8.30.—Phthisis Rates: their Significance and their Teaching: Dr. A. Ransome, F.R.S.—Demonstration of a New Method for Recording the Incidence of Infectious Disease: C. H. Cooper.

SATURDAY, May 20.

Royal Institution, at 3.—The Evolution of the Kingship in Early Society: Dr. J. G. Frazer.

MONDAY, May 22.

Society of Arts, at 8.—The Uses of Electricity in Mines: H. W. Ravenshaw.

Victoria Institute, at 4.30.—Minerals and Metals of the Old Testament: Cavaliere W. P. Jervis.

TUESDAY, May 23.

Society of Arts, at 4.30.—The Cape to Cairo Railway: Sir Charles H. T. Metcalfe, Bart.

Anthropological Institute, at 8.15.—The Great Zimbabwe: Franklin White.

WEDNESDAY, May 24.

Linnean Society, at 8.—Anniversary Meeting.

Geological Society, at 8.—On the Igneous Rocks occurring between St. David's Head and Strumble Head (Pembrokeshire): J. V. Elsden.—(1) The Rhætic and Contiguous Deposits of Glamorganshire; (2) On the Occurrence of Rhætic Rocks at Berrow Hill, near Tewkesbury (Gloucestershire): L. Richardson.

Society of Arts, at 8.—Modern Lightning Conductors: Killingworth Hedges.

THURSDAY, May 25.

Royal Society, at 4.30.—Croonian Lecture on "The Globulins": W. B. Hardy, F.R.S.

Royal Institution, at 5.—Electro-magnetic Waves: Prof. J. A. Fleming, F.R.S.

Institution of Electrical Engineers, at 8.—Wireless Telegraphy Measurements: W. Duddell and J. E. Taylor.

FRIDAY, May 26.

Royal Institution, at 9.—The Development of Spectro-chemistry: Prof. J. W. Brühl.

SATURDAY, May 27.

Royal Institution, at 3.—The Evolution of the Kingship in Early Society: Dr. J. G. Frazer.

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THURSDAY, MAY 25, 1905.

THE ANOPHELES MOSQUITOES OF INDIA.

A Monograph of the Anopheles Mosquitoes of India. By S. P. James and Dr. W. G. Liston. Pp. 132 and plates. (Calcutta and London: Thacker and Co.) Price 24*s.* net.

THERE is one feature in which this book far surpasses any other devoted to mosquitoes, viz. the coloured plates. The authors and their artist, Dr. Turkhud, are to be congratulated on the excellence of these pictures. It will be now possible to compare an Indian Anopheline with a plate, and with practical certainty to be sure of its identity. The same could not be said of any representations of mosquitoes hitherto produced. These plates are beautifully executed, and depict faithfully the bands on the palpi, the spots on the wings, and the leg markings. It is a pity that some few Anophelines are not represented, but of these we have, of course, the systematic description.

The book is divided into two parts: (1) general, (2) systematic. The first chapter gives a general account of mosquitoes, egg, larva, nymph, and external anatomy of the imago. The description is clear and adequate for medical men, for whom the book is primarily written. We think perhaps a short account of the internal anatomy might have been added, as a knowledge of this is so important. The chapter ends with a short account of Theobald's classification of mosquitoes, which the authors are unable to accept. Instead of dividing the subfamily Anophelina into twelve genera as Theobald has done, they place them all (at least the Indian ones) in the old genus Anopheles. We cannot help thinking that this, in spite of some of the difficulties of Mr. Theobald's classification which they point out, is a retrograde step. The authors deal with a total of twenty-four Indian species; the total number of Anophelines, however, now amounts to nearly a hundred, and, to say the least, it would be very inconvenient, if not impossible, to deal with these if we placed them all in a single genus. In some of these, *e.g.* Lophoscelomyia, Christya, the difference in scale structure is so marked from, for example, a typical Myzomyia that we prefer to follow Mr. Theobald and put them in separate genera. Again, we do not know whether the authors would propose, ignoring scale structure, to arrange the rest of the Culicidæ in a single genus, Culex, and take no notice of the obvious differences in scale structure, *e.g.* between Mucidus and Culex, or between Stegomyia and Culex. We think, to be logical, they should do so, and try to classify them by palpal bands and leg markings; but this would be well-nigh impossible. We think the authors would have made their position more secure if they had been content with placing in the same genus only those in which they failed to recognise the differences in scale structure defined by Mr. Theobald. It may be granted that doubts sometimes arise, but we cannot regard this as an excuse for merging into a single genus those in which the differences are well marked and easily appreciable.

The second chapter contains a synoptic table of the Indian species of Anophelines, based upon the author's classification according to palpal bandings, wing spots, and leg markings; the chapter concludes with a description of the method of identifying Anopheline larvæ. The essential points are very clearly set forth, and there follows a classification—a modification of that originally constructed by Stephens and Christophers. One point noticeable as showing that even all the Indian Anopheline larvæ are as yet unknown is that the table only contains eighteen species, whereas the table of imagines contains twenty-four. This table should be of great assistance in helping actual workers in identifying their catch of larvæ from any source.

The third chapter is devoted to the habits of Anophelines. These most interesting questions are, as the authors admit, only beginning to be studied, and now that a book of this kind enables observers to identify their mosquitoes, we may expect much light on these questions—questions of vital importance, but to which many pay no attention. One of the most interesting problems is the distance of flight of Anophelines. Christophers and myself found in Africa instances which proved conclusively that normally the flight of Anophelines was quite a restricted one, to be counted in yards and not in miles, as was not uncommonly stated. A striking example of this we found in the central portion of Freetown, Sierra Leone. Although we lived there for several months during the dry and rainy seasons, we never discovered Anophelines in our rooms, yet a quarter of a mile away they existed in myriads in the native huts; and many other similar instances were observed by us. Yet in Mian Mir observations are quoted to show that *P. fuliginosus* will on occasions fly two and a quarter miles, and *M. rossii* three-quarters of a mile. But, of course, the conditions at Mian Mir are very different—in one case an open plain, in the other a crowded town. Closely bound up with this problem is the question of dispersal of Anophelines. Two of the most important means are (1) by flight, (2) "by a gradual spreading, by short stages, from areas in which they are abundant." This latter method is, it seems to us, one of the most important and overlooked by those who have no intimate knowledge of mosquito habits, but who readily draw up schemes for their wholesale destruction. We agree with the authors when they state, "observers who consider that Anopheles can be materially reduced in numbers by the obliteration of all breeding places in the immediate vicinity of dwellings, rely chiefly upon the suppositions that the range of flight of these insects is very limited and that they do not disperse any considerable distance from their breeding grounds. It would appear from the observations just recorded that such suppositions are incorrect, and if this is so, the task of materially reducing the number of Anopheles in any place will undoubtedly be one of great magnitude."

Again, granted that Anophelines have been diminished in numbers in a certain area, it by no means follows that the malaria will be diminished. We could furnish many instances observed by us in Africa where Anophelines were extremely scanty (but present) yet the malarial index was high. In fact, it is not *always* possible to trace any relation between the number of Anophelines and the value of the malarial index, although on the contrary it often is so. Finally, we may point out that we have at our disposal an accurate and easily applied method of determining whether anti-mosquito measures have diminished malaria. It is now universally accepted by medical men, but not generally known to the layman, that the great source of malaria in the tropics lies in the native children, who to the outward eye show no signs of ill-health, though they contain in their blood malarial parasites. The malarial index or endemicity is the percentage of children under ten years of age that harbour parasites. It is not uncommonly 100 per cent.

If, then, the anti-malarial measures have reduced malaria, this figure must decrease. If malaria has been abolished it must be zero. (It is hardly necessary to state that, in determining this index, children of the same age must be selected for comparison, and the comparison must be made at the same time of the year before and after operations; such precautions are obvious, and are, of course, always taken by those engaged in such observations.) To sum up, no facts are convincing where this proof is not adduced. If the malarial endemicity is reduced to zero, then anti-mosquito measures have been completely successful—but not until then.

Let us return, however, to the book. We think it would have been advantageous, considering the great importance of the subject, if the authors had compiled a tabular statement of those species that are known to transmit malaria *in nature,* though the data on this point can be found by search. At present, then, out of twenty-four Indian Anophelinæ it has only been shown that three convey malaria in nature, viz.:—*M. culicifacies,* by Stephens, Christophers, and James; *M. listoni,* by Stephens, Christophers, and James; *P. fuliginosus,* by Adie; and we know with practical certainty that *M. rossii* does not. The third chapter contains many interesting details of larval life, but it is to be hoped that many observers, using this book as their guide, will study the subject further and fill up the many lacunæ.

Chapter iv. is devoted again to the vexed question of classification. Then follows part ii., containing the systematic description of each species. The descriptions are excellently done, clear, and sufficient, and not overloaded with details which terrify the already overburdened medical man in the tropics. In fact, this book admirably fulfils the object of enabling "medical men engaged in tracing the connection between mosquitoes and human disease to identify and speak with precision of the species implicated." These words are attributed to Prof. Ray Lankester, and if they represent his words we cannot but think that the elaborate monograph of the Culicidæ, excellent as it is, issued by the museum authorities has not had this result. The majority of medical men in the tropics can ill afford the time or inclination to read these detailed descriptions. We think if the museum authorities would issue concise but adequate accounts of, say, the Anophelinæ only, medical men would be greatly helped. For a few shillings the United States authorities publish excellent bulletins on various subjects, *e.g.* the ticks, the flukes, and so forth, but if a medical man in British possessions wants to identify the species of tsetse-fly he is working with he must buy a monograph issued by the museum costing fifteen shillings. If he wants to know anything about ticks, the museum leaves him in the dark. Seeing what medical men have done recently in elucidating malaria, sleeping sickness, and, most recently of all, tick fever, we think they might reasonably expect some help in return. We would point out finally one small matter which might be corrected in a future edition. In the list of illustrations only i–x are mentioned, though these number xv at least. The arrangement of the plates is erratic, *e.g.* v, xi, vi, xiv, vii, &c., so that they are very difficult to find. The proofs have evidently been carefully read, and we have detected no error of any importance.

The authors have had the great advantage of describing species caught on the spot and studied under their natural surroundings. We trust somebody will be found in Africa to write an equally good text-book of African Anophelines.

We think that all medical men in India will feel grateful to the authors for this excellent work.

J. W. W. STEPHENS.

EXERCISES IN PHYSICS.

Notes and Questions in Physics. By Prof. John S. Shearer. Pp. vii+284; illustrated. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1904.) Price 7*s*. 6*d*. net.

THE present volume has been written to take the place of a similar book prepared several years ago by Prof. C. P. Matthews and the author. Actual experience in the class-room indicated the desirability of certain extensions and changes in the text, and also of many explanatory notes and solutions.

The book is, in reality, a collection of problems—many of which have been selected from examination papers—together with occasional hints with regard to solving them, and very brief introductory paragraphs to each section which explain the principal technical terms referred to therein. It will be easily understood, therefore, that the book is not intended to take the place of regular text-books, lectures, or of laboratory practice. It is designed, indeed, to accompany these. The supply of problems in many text-books is exceedingly scanty—the present volume amplifies the supply. It will be found of great service to the teacher in suggesting problems to set as class work. As no answers are given, there will be less temptation to the teacher merely to quote the selected problems; anyone who is alive in his subject will modify them to suit his

own preferences. The absence of answers makes the book of no use to the private student who requires some check on the work he does. On the whole, we think that the utility of the book would be increased by the addition of these; or, if this is not favoured, then by their publication in a separate volume.

The whole ground of physics is covered, including mechanics. The general difficulty is only slight. By far the largest number of the problems could be tackled by a first-year university student. In mechanics very many are even of matriculation standard; thus, "The Washington Monument is 169 metres high. In what time will a stone fall from top to bottom?" Mingled with these are a few requiring the calculus. Many require only a qualitative answer; thus, 'Explain why it is difficult to walk up an icy hill." These remarks are equally true of the other sections; thus, in electricity, the following is a commonly occurring type of question:—"Two copper wires are of the same cross-section, but one is twice as long as the other. Compare their resistances." Indeed, this question illustrates the general character of the book very well. Take each clause of an ordinary text-book and express it in question form—that seems to have been the mode of formation. We miss the bright sparkle of genius which flashes out from the examination papers of many of the examiners that we know. Still, we think, and we have said, that many will find it a very useful book.

Turning next to the hints, which, we think, might be multiplied with advantage, these are not always above criticism. Take, for example, the following:—

"Prove that a gun free to move backward and the bullet fired from it have the same momentum when the bullet leaves the gun. Note: Action and reaction are equal and opposite. Force on gun = force on bullet.

$$M_g A_g = M_b A_b \text{ [A = acceleration]}$$

Multiply by t

$$M_g V_g = M_b V_b."$$

We are of opinion that equality of the two momenta is the fundamental fact which can be proved only by experiment. The operation of changing from a variable acceleration to the change in velocity is inadequately represented by a multiplication by the time.

The arrangement of the problems seems to have been imperfectly attended to; very many questions are to be found in sections with which they have nothing to do. For example, under the head "Colour" occur a series of questions such as "Why does an object appear equally bright at all distances from the eye?"

A series of useful tables completes the volume. The numerical constants given are not always scrupulously exact. For example, log $\pi = 0{\cdot}497150$ and not $0{\cdot}497149$ (as given) when only six figures are to be retained. Again, why should a student (or teacher) be misled into taking log π^2 as $0{\cdot}994299$ when the much simpler number $0{\cdot}994300$ is more exact? There are two other examples of this on the same page. This is the kind of number which, if quoted at all, ought to be checked and re-checked until the author is sure that he has it right.

MATHEMATICAL METAPHYSICS.

Principien der Metaphysik. By Dr. Branislav Petronievics. Vol. i., part i. Pp. xxxi+444. (Heidelberg: Carl Winter, 1904.) Price 15 marks.

THIS is the first instalment of a new work on metaphysics. It discusses only general ontology and the formal categories (in other words, the general ontological and the quantitative problem). The second part of the same volume, we are informed, will deal with the qualitative and hyper-metaphysical problems, and the second volume will then go on to cosmology and psychology.

The author's guiding principle is expressed in the motto, "Correct mathematical ideas are the key for the solution of the riddle of the universe." We doubt if this will command the acceptance of any metaphysicians whose interests are not primarily mathematical. Mr. Balfour, in a well-known passage, has pointed out how often the battles of theology are decided beyond the borders of that study; it is a little hard if the metaphysician, who contemplates all time and all existence, is to be fettered by the geometrical views of his age, and before he makes any headway in *prima philosophia* must study closely the hundred-page account of the new geometry "with 3 tables containing 56 geometrical figures."

We doubt in particular whether ordinary metaphysicians will ever accept the "discrete" or atomic view of space here given, however fashionable it may be among modern mathematicians. That view goes back to the Arabic school of the Mutakallimun. Dr. Petronievics adopts, with some slight differences, the development of the theory advocated by Giordano Bruno. He distinguishes two kinds of "point," *Mittelpunkt* (*der reale mit Inhalt erfüllte Punkt*) and *Zwischenpunkt* (*der irreale die leere nichtseiende Lücke darstellende Punkt*). The discussion of time follows the same atomic lines. The plain man wonders in what fashion precisely his old friend "Achilles and the tortoise" is to be dealt with on these principles. (That fallacy, it is true, appeals in the first instance to those who combine an atomic view of Time with a non-atomic view of Space, but it has surely its difficulties for any who regard either Time or Space as discrete.) The same guileless innocent, while understanding readily the general data which enable a Kelvin to calculate the approximate size of "atoms" of water, does not see quite so readily how we can ever hope to reach the data for determining the size of atoms of impalpable Time or Space. Nor, again, does he see the special benefit of abolishing the old Euclidean point in favour of the new one endowed with both position and magnitude, when to all intents he is compelled, a moment later, to revive in the term *Zwischenpunkt* the "point" of his earliest geometrical affections—"that which has position but *not* magnitude"; and he recalls the Horatian tag, "*Expelles furca, tamen usque recurret.*"

Still, the discussion contained in this volume is stimulating, and considerable dialectic power is displayed. One will watch with interest in the later volumes whether the author succeeds in dealing with

his various problems without always recurring to the mathematical point of view. Unfortunately, one word must be said regarding the typography. The present reviewer has seldom read a book so badly corrected for the press. There are two pages of corrigenda; but a full statement of all the small misprints would with difficulty be contained in four or five pages more. If it is not *c* for *o* or *e*, it is *u* for *n*, or *l* for *t*, or *b* for *h*, or *das* for *dass*. This is the more to be regretted because—granted the author's point of view—the *i*'s of the philosophy are quite carefully dotted.

BRITISH MINERALS.

A Handbook to a Collection of the Minerals of the British Islands in the Museum of Practical Geology. By F. W. Rudler, I.S.O. Pp. x+241. (London: H.M. Stationery Office, 1905.) Price 1*s*.

SINCE his retirement from the post he so long and efficiently held as curator of the Museum of Practical Geology, Mr Rudler has installed in that museum a collection illustrative of the modes of occurrence of British minerals. The museum has long possessed collections of British rocks, fossils, and ores, the last named arranged under the various metals which they contain. In the new collection, which is neatly arranged in twelve table-cases, the minerals found in each district are brought together; half the space is allotted to Cornwall and Devon, one-eighth to Scotland, Ireland, and the Isle of Man, and the remainder to the rest of England, the divisions being roughly according to the several mining districts, with a general group for the minerals of the Neozoic strata. The specimens, to the number of 1652, have mostly been selected from the Ludlam collection, which was bequeathed to the museum in 1880; though mostly small in size, they are of excellent quality. In addition to the name and locality attached to each specimen, there are many explanatory labels in the cases, and the present volume admirably serves the purpose of a guide to the collection.

The volume is by no means a tedious catalogue or descriptive list of all the individual specimens, but is rather an extremely readable and interesting account of the mode of occurrence and history of the more common British minerals, especially those which are of economic importance. Instead of long descriptions of the characters of species, much is said of their paragenetic relations, and many valuable suggestions are made as to their possible modes of origin. The book will therefore be found interesting and instructive not only to mineralogists, but also to geologists and miners; whilst quite apart from the collection, for which it is primarily intended, it will have a permanent value as a treatise. In this connection mention may be made of the numerous and extremely valuable references to original authorities consulted in the preparation of the work.

The mode of treatment is a novel one, and necessarily involves a certain amount of repetition, especially in the case of some of the more commonly occurring minerals, such as quartz, calcite, galena, &c., which may be found in almost all the different districts; but this repetition is not tedious. As an example, the district of Cornwall and Devon may be taken, in which the main groups are as follows:—cassiterite, minerals associated with cassiterite, copper sulphides and sulpho-ferrites, copper-bearing minerals of the gozzans, arsenates and phosphates of the copper-gozzans, ores of lead, zinc, antimony, &c., sulphides and sulpho-salts, ores of iron, &c., minerals of the rarer metals, the spars of the mineral veins, miscellaneous minerals.

Apart from a few minor misprints, the only point which calls for criticism is that undue importance seems to have been attached to many quite trivial and local names. As for the printing, there is certainly much room for improvement; the lines are so badly broken that it is surprising that the whole did not fall to pieces in the course of printing.

L. J. S.

OUR BOOK SHELF.

Moths and Butterflies. By Mary C. Dickerson. Pp. xviii+344; with 200 photographs from life by the author. (Boston, U.S.A., and London: Ginn and Co., n.d.) Price 5*s*. net.

THIS is a prettily got-up book, intended for the training of classes in "nature-study," with reference to a considerable number of common and conspicuous North American butterflies and moths, the life-history of which is very fully described and illustrated. The concluding chapter, on collecting, keeping, and studying, recapitulates the points to be noted in practical observations on the insects themselves.

To English readers the book will be useful for the information it supplies about American forms, and also as indicating a similar method of study for British insects, but many of the species here noticed are much larger and more conspicuous than those likely to fall under our own observation, among them being several species of Papilio, and large Saturniidæ.

The figures, of which (including apparatus, &c.) there are 233 in all, are generally very good, though some are indistinct. The frontispiece, representing a Smerinthus at rest, and Fig. 17, on p. 147, representing a procession of the young caterpillars of Saturnia, may be specially noticed. But it looks odd to see a Smerinthus closely allied to our own *S. ocellatus* called "a most beautiful little moth" (p. 232); and, though we do not object to the use of appropriate English names, we are sorry to see on p. 231 a Sphinx allied to *S. convolvuli* called "the Humming-Bird Hawkmoth," a name by which the very different *Macroglossa stellatarum* has been known all the world over, ever since the commencement of the study of entomology.

We had expected to find some notice of the gipsy moth, the crusade against which has recently been given up in America in despair, but find only a passing reference. A few British species are noticed, such as *Vanessa antiopa*, called in America the mourning cloak, a translation of its German name; *V. atalanta*, *Pieris rapae*, &c.

A great deal of useful general information is given in the book, and it seems on the whole to be careful and accurate. One statement, however true in the abstract, ought not to have been made without qualification or explanation in a popular book. On p. 267 we read, "We are familiar with the fact that all living

creatures develop from eggs." Further comment is needless.

Although published in 1901 and mentioned in the *Zoological Record* for that year, this book has not previously been brought under our notice.

Second Stage Magnetism and Electricity. By Dr. R. Wallace Stewart. Second edition. Re-written and enlarged. Pp. viii+416. (London: W. B. Clive.) Price 3s. 6d.

This book is primarily intended to serve the purposes of a candidate preparing for the second stage examination under the Board of Education (secondary branch). In reading it, we have by no means made our first acquaintance with Dr. Stewart, and the perusal has left us of our old opinion that, whether regarded as text-books intended to prepare a student for a particular examination or as a source of culture, the books prepared by the author can be very earnestly recommended. He is a lucid and accurate writer. He knows where to draw the line so that an elementary student shall not be repelled by the complication of a subject.

The present volume is brought up to date. The importance of the field—that is, the medium surrounding an electrified conductor or magnet—is insisted on; perhaps even their importance is emphasised too much. The tendency of modern thought amongst physicists is to restore to a conductor part, at any rate, of the position that it held in pre-Maxwellian days. The dielectric plays a most important part—that is a position, won for it by Maxwell, which it can never lose. At the same time, one should not lose sight of the fact that there *must* be some mechanism at the ends of a line of induction, and to-day that mechanism is being studied under the name of *electron*. The electron is an essential part of a conductor, and the complete phenomena of electricity are not fully accounted for without including it.

The volume is almost entirely re-written. It is not surprising, therefore, that there are some unfortunate slips which have escaped the vigilance of the reader. As these are misleading, we will state that on the bottom of p. 33 "positive" and "negative" should be interchanged. The following phrase (p. 42) is very misleading:—"The portions of those walls, which are, as it were, in the shadow of these objects, possess no induced charge." We think that the first thirty pages might be improved in any later edition. Considerable care has evidently been taken; yet in many cases confusion is introduced by the neglect of some tiny detail. Thus, in describing the attraction and repulsion of a pithball with subsequent re-attraction, *if in the interval it comes in contact with an earth-connected body*, the phrase that we have put in italics is omitted; and in several cases where a body is touched to earth it is not explicitly said whether the contact is to be broken before a succeeding operation is performed or not. Why is it "evident" (p. 16) that doubling a charge will double the force it exerts on another charge?

Memoria sobre el Eclipse Total de Sol del día 30 de Agosto de 1905. By D. Antonio Tarazona. Pp. 125. (Madrid: Bailly-Bailliere E. Hijos, 1904.)

Those who are familiar with the Spanish language and have made up their minds to go abroad and see the approaching total eclipse of the sun will find in this book a great amount of useful information relating to this interesting event. The work is issued from the Madrid Astronomical Observatory, the director, Francisco Iñiguez, having contributed a brief preface, and contains full particulars concerning the elements of this eclipse; in fact, it might be considered a treatise on the subject, so complete is the information. In addition to a great many data which will be of special use to astronomers, there will be found a very full list of towns, in alphabetical order, at which totality occurs, with the times of the different phases of the eclipse. More generally useful perhaps will be found the maps at the end of the volume. These include a map of the world showing the position of the track from the commencement to the end of totality over the earth's surface. A second illustrates on a larger scale the Spanish portion of the track, with special lines showing the times of occurrence and duration of totality. The third, on a much larger scale (1 : 1,000,000), indicates that part of Spain alone over which the shadow sweeps, and is very complete as regards names of places, railways, &c. Lastly, two star charts are added, one showing the position of the eclipsed sun among the stars, and the second a key map to this chart giving the designations of the stars and planets in this region.

Visitors to Spain will do well to supplement their literature by securing this volume, and thanks are due to the Madrid Observatory for producing so useful a book so far in advance of the event.

Naturalistische und religiöse Weltansicht. By Rudolf Otto. Pp. 296. [Tübingen: J. C. B. Mohr (Paul Siebeck), 1904.] Price 3 marks.

No better book than this could be recommended to the young philosophical or theological student who wishes to obtain a clear and comprehensive view of the debatable ground where science, philosophy, and theology meet. The author is well read, a skilful debater, a vigorous writer; and as handbooks ought not to be unnecessarily multiplied, it is to be hoped that this one will be translated.

Like many other works in defence of religion in general, the book is not so strong on the constructive as on the critical side. The author refers with approval to the attitude of Kant when he solved certain contradictions or antimonies by a reference to the world of things in themselves. As this is precisely the point where Kant's philosophy is most seriously questioned, the argument probably suffers to that extent. But, on the other hand, the author fully realises the unity of the various phases of the one problem religion *versus* naturalism, and the harm which has been done by concentrating the attention on one phase (*e.g.* the question of miracles) as if it were the whole.

The work is valuable mainly for its survey of the most interesting biological theories of the last century, from Darwin, Häckel, Weismann, down to Wolff, Korschinsky, Driesch. The philosophical development of this last writer is sketched in an enlightening fashion. With regard to the general theory of development and "descent," the author comes to the conclusion that with the confirmation of any such theory only something relatively external is given, a clue to creation, which does not so much solve its problems as group them afresh. The index at the end of the work gives an explanation of the more difficult terms employed by modern theorists.

An Introduction to Projective Geometry and its Applications. By Dr. Arnold Emch. Pp. vii+267. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 10s. 6d.

This text-book of modern projective geometry forms an admirable introduction to the subject, and should be known to all who are interested in this branch of mathematics. The first chapter deals with the general properties of projective ranges and pencils and their products, including harmonic and perspective projection, and the projective properties of the circle. Then

follows an investigation of collineation in a plane, comprising perspective transformations, and the linear transformations of translation, rotation, and dilatation, with combinations of these. The intimate relation that exists between projective and descriptive geometry is shown. The third chapter gives the general theory of conics, the projective properties of the circle being extended to conics by perspective transformations. The next chapter deals with pencils and ranges of conics and their products, and especially with cubics, the latter being classified under the five standard types by the help of the Steinerian transformation. Throughout the book analytical and geometrical methods are employed side by side, some portions of the subject being better suited to the former treatment; moreover, the analysis affords excellent illustrations of modern analytical geometry. The main purpose of the author has been to develop the subject in regard to its practical applications in mechanics, and the last chapter is devoted to such examples. Thus we find problems in graphic statics, plane stresses, and in the stress ellipse of an elastic material, and there is an interesting account of various linkages by means of which linear and perspective transformations can be mechanically obtained. The book is excellently got up in every way, and the diagrams are quite perfect and may well serve as models of what such figures ought to be. The author is a very clever draughtsman, and his skill as a writer is equally pronounced.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Fictitious Problems in Mathematics.

IN my younger days it was well recognised that such statements as "perfectly smooth" and the like were mere conventional phrases for designating an ideal state of matter, which was assumed to exist for the purpose of simplifying the mathematical conditions as far as possible. Nobody can learn mathematics without working out a large number of problems and examples, and in order to make these sufficiently easy for the beginner, various fictitious hypotheses have to be introduced.

Similar objections would apply to the phrase "frictionless liquid"; but it would be impossible for anyone to learn hydrodynamics without first studying the mathematical theory of this fictitious form of matter. In fact, the introduction of viscosity leads to such formidable difficulties, that nobody has yet succeeded in solving such a simple problem as the motion due to a doublet situated at the centre of a sphere; and the solution, if it could be obtained, would throw much light on the mode of attacking more difficult problems. A. B. BASSET.

May 28.

IN NATURE of May 18 the wording of a problem set near the beginning of my "Rigid Dynamics" is rather adversely commented on. In the problem a man is described as walking along a perfectly rough board which rests on a smooth table, and the criticism is that the two suppositions are inconsistent; but this depends on what is meant by the words used, and perhaps I may be allowed to make an explanation.

When bodies are said to be perfectly rough, it is usually meant that they are so rough that the amount of friction necessary to prevent sliding in the given circumstances can certainly be called into play. In art. 156 of the treatise on dynamics, just after the laws of friction have been discussed, the words "perfectly rough" are defined to have this meaning. The board in question has therefore no special peculiarity. All that is stated is that the coefficient of friction between the man and the board exceeds a certain finite quantity.

The board rests on a smooth table, but the coefficient of friction now depends on both the board and the table, and this may be quite different from that between the man and the board. There is nothing amiss in supposing this coefficient to be zero. One way of effecting this experimentally would be to polish the table and remove all roughnesses from it. This was the plan indicated.

Where, then, is the inconsistency?

By using the ordinary abbreviations of language, the wording of the question has been made concise, and thus attention was specially directed to the dynamical principle involved in the solution.

The problem has been understood by so many students in the sense above described, and worked without a single objection having been raised, that I think the meaning must be perfectly clear. Indeed, I cannot imagine what other meaning it could have. E. J. ROUTH.

May 20.

On the Spontaneous Action of Radio-active Bodies on Gelatin Media.

IN the course of some experiments on the formation of unstable molecular aggregates, notably in phosphorescent bodies, I was led to try whether such dynamically unstable groupings could be produced by the action of radium upon certain organic substances. It will scarcely be necessary to enter here into an account of the many speculative experiments which I have at one time or another tried, but it will suffice if I describe, as briefly as possible, the experiment which, amongst others, has led to a very curious result, and that is the effect of radium chloride and radium bromide upon gelatin media, such as those generally used for bacterial cultures.

An extract of meat of 1 lb. of beef to 1 litre of water, together with 1 per cent. of Witter peptone, 1 per cent. of sodium chloride, and 10 per cent. of gold labelled gelatin, was slowly heated in the usual way, sterilised, and then cooled. The gelatin culture medium thus prepared, and commonly known as bouillon, is acted upon by radium salts and some other slightly radio-active bodies in a most remarkable manner.

In one experiment the salt was placed in a small hermetically sealed tube, one end of which was drawn out to a fine point, so that it could be easily broken. This was inserted in a test-tube containing the gelatin medium. The latter was stopped up with cotton wool in the usual way with such experiments, and then sterilised at a temperature of about 130° C. under pressure for about thirty minutes. Controls without radium were also at various times thus similarly sterilised.

When the gelatin had stood for some time and become settled, the fine end of the tube containing the radium salt was broken, from outside, without opening the test-tube, by means of a wire hook in a side tube.

The salt, which in this particular experiment consisted of $2\frac{1}{2}$ milligrams of radium bromide, was thus allowed to drop upon the surface of the gelatin.

After twenty-four hours or so in the case of the bromide, and about three or four days in that of the chloride, a peculiar culture-like growth appeared on the surface, and gradually made its way downwards, until after a fortnight, in some cases, it had grown fully a centimetre beneath the surface.

If the medium was sterilised several times before the radium was dropped on it, so that its colour was altered, probably by the inversion of the sugar, the growth was greatly retarded, and was confined chiefly to the surface.

It was found that plane polarised light, when transmitted through the tube at right angles to its axis, was rotated left-handedly in that part of the gelatin containing the growth, and in that part alone.

The controls showed no contamination whatever, and no rotation. The test-tubes were opened and microscopic slides examined under a twelfth power. They presented the appearance shown in Fig. 1. At first sight these seemed to be microbes, but as they did not give subcultures when inoculated in fresh media they could scarcely be bacteria. The progress of any of the subcultures after a month was extremely small, and certainly

too small for a bacterial growth. It was not at all obvious how bacteria could have remained in one set of tubes and not in the other, unless the radium salt itself acted as a shield, so to speak, for any spores which may originally have become mixed with the salt, perhaps during its manufacture, and when embedded in it could resist even the severe process of sterilisation to which it was submitted.

On heating the culture and re-sterilising the medium, the bacterial-like forms completely disappeared; but only temporarily, for after some days they were again visible when examined in a microscopic slide. Nay, more, they disappeared in the slides when these were exposed to diffused daylight for some hours, but reappeared again after a few days when kept in the dark. Thus it seems quite conclusive that whatever they may be, their presence is at any rate due to the spontaneous action of the radium salt upon the culture medium, and not alone to the influence of anything which previously existed therein.

When washed they are found to be soluble in warm water, and however much they may resemble microbes,

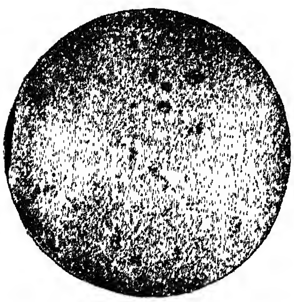

FIG. 1.

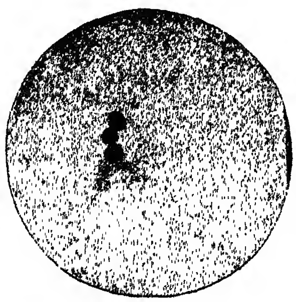

FIG. 2.

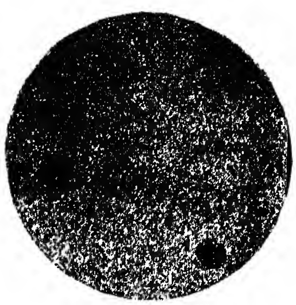

FIG. 3.

they cannot for this reason be identified with them, as also for the fact that they do not give subcultures as bacteria should.

Prof. Sims Woodhead has very kindly opened some of the test-tubes and examined them from the bacteriological point of view. His observations fully confirm my own. He assures me that they are not bacteria, and suggests that they might possibly be crystals. They are, at any rate, not contaminations.

I have tried to identify them with many crystalline bodies, and the nearest approximation to this form appears to be that of the crystals of calcium carbonate, but these are many times larger, and, in fact, of a different order of magnitude altogether, being visible under comparatively low powers; and are, moreover, insoluble in water.

A careful and prolonged examination of their structure, behaviour, and development leaves little doubt in my mind that they are highly organised bodies, although not bacteria.

Unfortunately the quantity is so very minute that a chemical analysis of their composition is extremely difficult. The amount of salt in the first instance is so small, and the number of aggregates, or whatever they may be, thus produced perhaps still smaller.

The most effective method of studying their properties, from the physicist's point of view, is that of long and, so far as possible, continual observation, a method similar to that which the astronomer is bound to adopt in his study of bodies over which he has not the control to deal with as he pleases.

From the accompanying photographs it will be observed that they are not all of the same size; they range from about 0·3 μ to the minutest specks; they are mostly, if not altogether, all of the same shape, and show distinct signs of growth; the larger ones appear to have sprung from smaller forms, and these in turn from still smaller ones, and they have all probably arisen in some way from the invisible particles of radium.

Fig. 2 distinctly shows the existence of nuclei in the larger and more highly developed forms, whilst Fig. 3 reveals, though indistinctly, what is their most remarkable property of all, and that is their subdivision when a certain size is reached. They do not grow beyond this size, but subdivide.

These photographs, together with the numerous results of eye observations, which indicate that a continuous growth and development take place, followed by segregation, leave little doubt that whilst on the one hand they cannot be said to be bacteria, they cannot be regarded as crystals either in the sense of being merely aggregates of symmetrically arranged groups of molecules, which crystals are supposed to be. The stoppage of growth at a particular stage of development is a clear indication of a continuous adjustment of internal to external relations, and thus suggests vitality.

They are clearly something more than mere aggregates in so far as they are not merely capable of growth, but also of subdivision, possibly of reproduction, and certainly of decay.

The subcultures do show, however slightly, some indication of growth after four or five weeks, although that growth is, I understand, too small for a bacterial subculture. Moreover, when examined in the polariscope they have not been found to yield the characteristic figures and changes of colour which crystals generally give.

Thus for these reasons I have been led to regard them as colloidal rather than as crystalline bodies, and probably more of the nature of "dynamical aggregates" than of "static aggregates," of which crystals are composed.

There appears to be a tendency amongst text-book writers to classify minute bodies which are not bacteria as crystals, but really without sufficient reason, and as these bodies cannot be identified with microbes, on the one hand, nor with crystals on the other, I have ventured, for convenience, in order to distinguish them from either of these, to give them a new name, *Radiobes*, which might, on the whole, be more appropriate as indicating their resemblance to microbes, as well as their distinct nature and origin.

Some slightly radio-active bodies appear also to produce these effects after many weeks.

A more detailed account of these experiments will be published shortly. This note merely contains some of the principal points so far observed.

I have to thank Mr. W. Mitchell, who sterilised the tubes, for the assistance he has rendered in these experiments.

JOHN BUTLER BURKE.

Cavendish Laboratory, Cambridge, May 10.

The Consolidation of the Earth.

THERE are several points in Dr. See's last letter (NATURE, May 11) calling for remark from the geological point of view.

(1) The effect of (hydrostatic) pressure at depths tends not to liquefaction (as in the case of the ice of a glacier) but to promote crystallisation, the condition of the greatest density of mineral matter, as I showed years ago in my little work on metamorphism in discussing the relation of the crystalline to the vitreous states. It is here that the importance of "solid-liquid critical state" comes in.

(2) We have no right to assume the existence at any stage of the history of our planet of a mere molten ball radiating heat directly into cold space, since in that "pre-oceanic stage" it was surrounded by a non-conduct-

ing mantle or "jacket" of such enormous density and altitude as to contain (as its main constituents) (*a*) the greater part of the water of the present hydrosphere in the vapour state; (*b*) the CO_2 locked up in the limestones and other carbonates of the lithosphere, as well as that represented by the coal and the living vegetation of the globe; (*c*) the hydrocarbons possibly represented by Archæan graphite, together with (*d*) the halogens (if atomic evolution had reached that stage), including the Cl_2 of the 73 per cent. of the NaCl of the salts of the present ocean. It is conceivable that a vast convection system existed, as the outer zones of the primordial atmosphere underwent cooling with consequent condensation, and descended towards the molten globe; but there could scarcely be contact generally between such cooler portions and the heated molten mass. The conditions would be rather such as are partly illustrated by what a student of physics is familiar with as the "spheroidal state" of a liquid floating on a cushion of steam above a hot plate of metal. Under the enormous pressure prevailing at the surface of the globe in that pre-oceanic stage of its history great quantities of superheated steam and other gases must have been mechanically included, and in some cases, perhaps, occluded, in the hot *crust* in the inceptive stages of its development by congelation; and in such circumstances, as I suggested seventeen years ago, superheated water in traces would probably enter into the composition of such silicates as *hornblende* and *mica,* the two most characteristic of the minerals of the heavier metals of the Archæan gneisses and schists. A year or two later that hypothesis received demonstration from the splendid work of de Kroustchoff (see NATURE, vol. xliii. p. 545, also *Bulletin de l'Académie des Sciences de St. Petersbourg,* tome xiii., "Über künstliche Hornblende," by K. von Chrustschoff). So, I take it, we can understand how such a crust could float on a magma of molten rock material, just as air-charged fragments of pumice or of charcoal float on water, yet sink quickly to the bottom under the exhausted receiver of an air-pump; or as even a coil of platinum foil (sp. gr. 21·5) can be made to float in water inside a good air pump, as it is pontooned by innumerable bubbles of distended atmospheric gases previously condensed upon its surface; or, again, as masses of lava slag of large dimensions are seen to float for a time upon the vast lake of liquid rock material in the crater of Kilauea. With tidal action in the magma greater when the moon was nearer the earth than at present, such a thin crust would easily undergo disruption, while portions of it would float off and be engulfed in the magma. This view, which I propounded some seventeen years ago, had been anticipated partly by Zöllner, and was adopted by the distinguished American geologist, Dr. A. C. Lawson, to explain the phenomena presented by the enormous inclusions of more basic rock masses in the gneiss of the Rainy Lake region, which excited great interest among our leading British geologists at the International Geological Congress in London in 1888, though it seems at the time to have been very imperfectly perceived by most of them. So far the evidence we have goes to support Dr. See's contention that the descent of such masses into the magma would be arrested long before they even approached the centre of the sphere; but one feels great difficulty in following his argument based on "Laplace's law," for reasons given in my former letter (NATURE, May 4).

By a slip I wrote, it appears, "impossibility" for possibility in the top line of p. 8 in my last letter.

Bishop's Stortford, May 17. A. IRVING.

The Spirit-level as a Seismoscope.

A MISCONCEPTION seems to prevail among seismologists as to the behaviour of a spirit-level. A displacement of the bubble is regarded as conclusive evidence of the tilting of the instrument. It should be pointed out, however, that this is far from being the case. For a second cause, equally effective in producing displacement of the bubble, is a horizontal acceleration of the instrument in the direction of the tube. The position of the bubble should be taken as indicating, not the normal statical vertical, but the dynamical residual vertical obtained by subtracting the acceleration of the instrument (as a vector) from that of gravity. (I disregard, in this statement, the slight lag due to viscosity.)

A couple of simple experiments, serving to emphasise this, may be suggested. A spirit-level is suspended in a horizontal position by two equal strings attached one to each end. In one case the strings hang vertically from two hooks; in the other case they are attached both to one hook. If the level is set swinging in the plane of the strings, then in the *first* case the bubble will be found to have an oscillatory movement relatively to the tube, the tube having linear acceleration but no tilting movement. In the second case the tube has both movements, but their effects exactly neutralise each other, and the bubble remains stationary in the tube. The expert waiter (may it be added?) who hurries about with plates of soup has a very effective empirical knowledge of this last case of compensation.

The motion of the bubble of a level has been brought forward as evidence in favour of the undulatory character of the disturbance producing the motion; but if the above suggestions are to be accepted, the motion might as reasonably be urged as evidence of a horizontal disturbance; the truth being that the instrument is sensitive to both disturbances, and is quite ineffective as a means of discriminating between them.

The evidence referred to is contained in the British Association report, 1902 (seismological committee report, p. 72). The view finds acceptance in some recent and authoritative works,[1] and seems, so far, to have passed unchallenged. G. T. BENNETT.

Emmanuel College, Cambridge.

A Feather-like Form of Frost.

THE accompanying photograph shows a form of frost not, I believe, usually seen except at a comparatively high altitude and unsheltered position. This photograph was

FIG. 1.—Frost "feathers" on windward side of rock.

taken on April 22 near the summit of Carnedd Llewelyn, N. Wales (3484 feet above sea-level). These delicate frost "feathers" appear gradually to grow outwards from the rock face on the windward side, and the delicacy of their form is, no doubt, modified in some degree with the varying rate of the wind and the temperature. I have found, in the same district, these "feathers" 9 inches from root to tip; those shown are about 6 inches long. They form a comparatively solid mass where they touch, but the tips keep distinct, and the whole mass is in reality very brittle, and easily breaks up into small pieces.

H. M. WARNER.

44 Highbury Park, N., May 16.

[1] Dutton, "Earthquakes in the Light of the New Seismology," p. 137; Davison, "A Study of Recent Earthquakes," p. 280.

THE EVOLUTION OF ENGRAVING IN THE STONE AGE.

WE have at various times directed the attention of our readers to this interesting subject, but new discoveries are continually being made. M. Ed. Piette, whose name is so well known in connection with his investigation of the famous cave of Mas-d'Azil, has given in *l'Anthropologie* (xv., 1904, p. 129) a classification of the deposits formed in caves during the age of the reindeer; starting as a geologist, he was firmly impressed with the fact that stratigraphy is at the root of fruitful advance in prehistory, and this end he has kept steadily in view. He gives the following table of relative chronology of the epochs which form part of the age of the reindeer:—

Epochs of Lartet and Christy	Epochs of G. de Mortillet	Epochs of E. Piette
Madelaine and	Magdalénienne	Gourdanienne
Laugerie-haute	Solutréenne	Papalienne
Moustier	Moustérienne	Mostérienne

The following is his cultural sequence, in which the epoch of Moustier does not take part, "as at that time the fine arts were not yet born":—

Age or series	Epoch or stage	Layer
Glyptic	Of engraving (Gourdanienne)	Of engravings and harpoons of reindeer antler
		Of engravings without harpoons or with very few harpoons
		Of engravings with cut-out contours
	Of sculpture (Papalienne)	Of sculptures in low relief
		Of sculptures in the round

The sculptors in the round used their flint tools for many purposes, including carving, chiselling, scraping, engraving, and burnishing; they certainly sketched their statuettes before modelling them, and they polished them. The sculptors in low relief scraped and burnished. Their works were not child's play, but the product of a real artistic sense. They studied and drew heads, limbs, and feet (Fig. 1). The sculptors in the round figured the flayed animal and even the skeleton. When mammoth ivory became rare reindeer antlers were employed for carving, and this appears to have led the way to the next artistic developments.

Many of the figures in this copiously illustrated paper are from the layer of sculptures in low relief; it was in this layer that several pieces were found decorated with circles and bold spirals (Fig. 2). At first these designs were carved deeply, they gradually became less deep, until in the Gourdanienne epoch they were merely lines. M. Piette believes the spirals were symbolic, and suggests that they had reference to snakes. Plant forms were rarely drawn, and of the very numerous animals engraved by far the most frequent were those upon the flesh of which the men fed.

As the relief in the designs became less and less, the artist had to employ the graver. At the end of the Papalienne epoch the artists undertook to execute very low reliefs on plates of bone not more than two millimetres in thickness. They made silhouettes, modelling the contours on both sides; but the great difficulty of carving such thin objects soon led to its abandonment. They replaced this style by cutting out contours and engraving the surface. This technique was common in the region of the Pyrenees, but rare to the north of the Garonne; being a transitional form it did not last long, whereas sculptures in low relief persisted into later layers.

At first, following the traditions of the sculptor, the engraver represented isolated animals, but the artists of Laugerie-basse appear to have been the earliest to design groups (Fig. 3). In the upper layers signs are engraved which M. Piette considers to be of the nature of inscriptions.

Thanks to the rigid stratigraphical method employed by M. Piette, he has been enabled to upset the

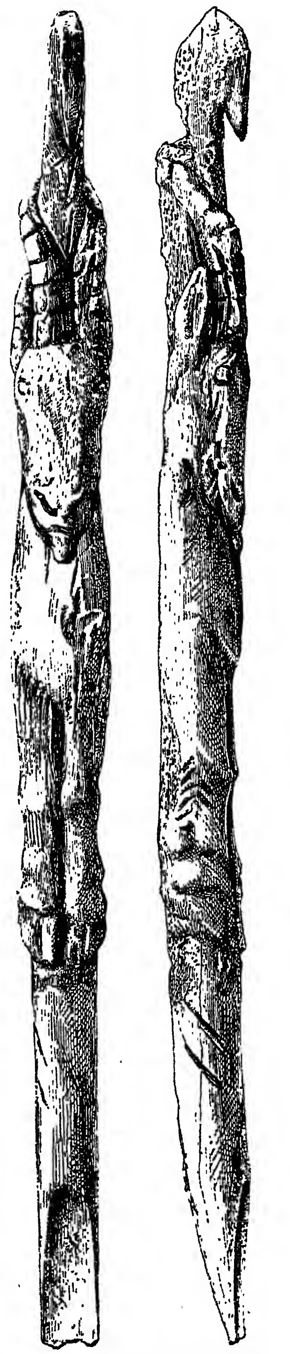

FIG. 1.—Bone Throwing-stick (Mas-d'Azil). Layer of sculptures in the round. Less than natural size.

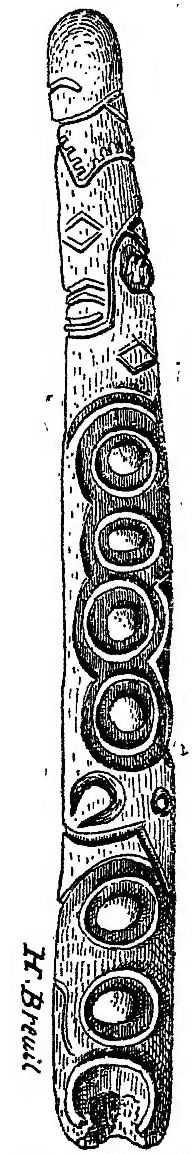

FIG. 2.—Portion of reindeer antler decorated with circles and other signs (Lourdes). Layer of sculptures in low relief.

a priori argument that sculpture was a later form of pictorial art than engraving, and has established that the reverse is the case.

In a subsequent paper, entitled "Les Écritures de

l'Age glyptique" (tome xvi., 1905, p. 1), M. Piette claims to have discovered "inscriptions composed of characters forming a primitive writing," all of which are from the layer of sculptures in low relief, and consequently from the earlier glyptic epoch. The first specimen figured by the author is that reproduced here as Fig. 2. First of all one must point out that only one side of this rod of bone is figured, but before the design can be understood it will be necessary to know what the whole design looks like. The author says, "The circle with central prominence appears to be a simplification of the circle with radiating centre which evidently signifies the sun or solar god. The rays have been suppressed in order to write the sign more quickly"; he then briefly gives the distribution of similar markings in prehistoric Europe and in Egypt. The lozenge is stated to be "certainly a symbol," and other signs are similarly believed to be symbols or hieroglyphs. "The spiral," for example, "has held a large place in primitive symbolism." This is possibly true, but spirals may mean many things in the art of existing backward peoples, and may be conventional symbols or more or less realistic representations; but it is extremely hazardous to make guesses as to what any given spiral may be intended to represent; the probability is that all such guesses will be incorrect, and the same remark applies to other elementary designs. Several spirals and concentric circles are figured by the author in juxtaposition, and the evidence seems to point to the conclusion that here, as in so many other instances from various parts of the world, the concentric circle or oval is a simplification of the spiral; if this be so, the theory that the concentric circles are degenerate rayed circles, *i.e.* suns, falls to the ground. The bold decoration on these bone objects in all probability had a meaning. Some of the designs may have been symbols; but, surely, it is somewhat far-fetched to describe them as hieroglyphs, and we cannot follow the author when he states (as he does in a letter to the editor), "According to me this inscription (Fig. 2) is the glorification of light."

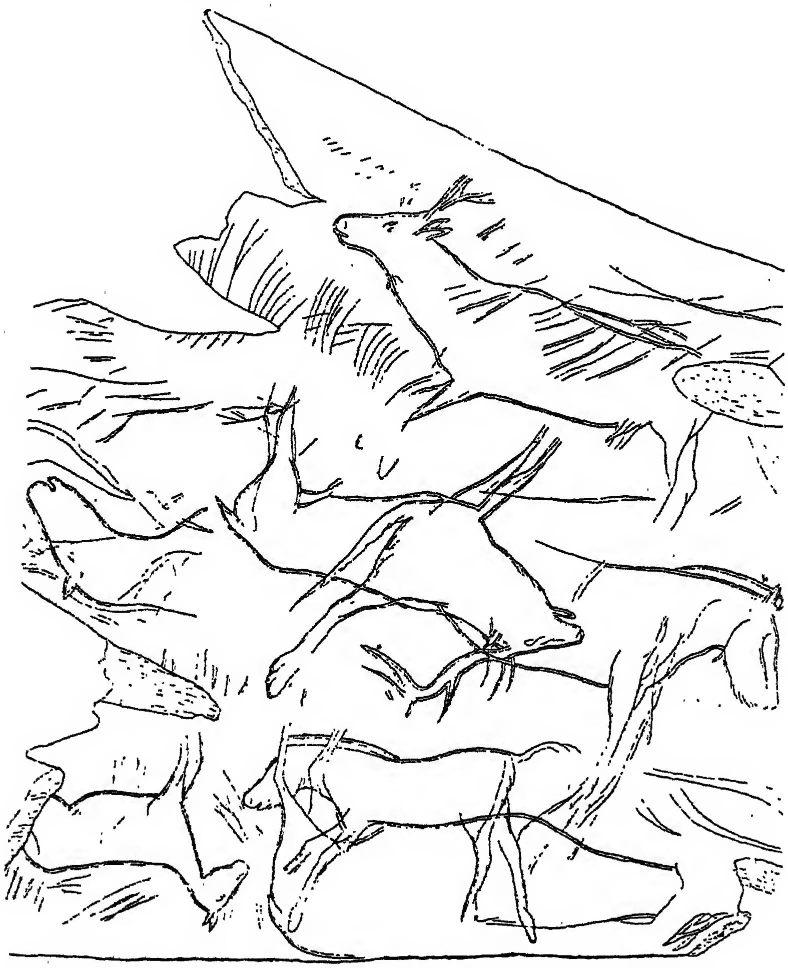

FIG. 3.—Engraving on bone (Lorthet). Layer of engravings without harpoons.

M. Piette also directs attention to certain linear markings on bones from various sites of the reindeer age. These he boldly claims to be true linear scripts, and suggests that the writings of la Madeleine and Rochebertier were continued into the linear script of Abydos without undergoing much change.

Archæologists are deeply indebted to M. Piette for the thoroughness with which he has carried out his investigations, and we must not unfairly criticise him if that enthusiasm which has carried him through his labours sometimes runs away with his more dispassionate judgment. He is probably quite correct in believing that the decoration on the bone objects he has discovered has a meaning, but judging from our experience of the decorative art of existing primitive peoples it is extremely improbable that we shall ever be able to decipher its meaning or unravel its symbolism. More evidence is needed before we can pass judgment upon the supposed linear script. A. C. H.

THE NEW DIPLODOCUS SKELETON.

ON Friday, May 12, in the presence of a large and representative company, Lord Avebury, on behalf of his fellow trustees, received from Mr. Andrew Carnegie the gift of the full-sized model of the skeleton of the gigantic American dinosaur known as *Diplodocus carnegii*, which has been mounted in the reptile gallery of the Natural History Branch of the British Museum under the superintendence of Dr. Holland, of Pittsburg, who has charge of the original specimens on which the complete restoration is based. Although the gigantic four-footed dinosaurs constituting the group Sauropoda were first made known to the world on the evidence of detached bones and teeth described by Mantell (Pelorosaurus) and Owen (Cardiodon and Ceteosaurus), it has been reserved for American palæontologists, working in the rich Upper Jurassic beds of Wyoming and Colorado, to give to the world an adequate conception of the huge proportions and extraordinary form of these strange reptiles. Strangest of all is perhaps Diplodocus (so named on account of

the double chevron-bones, which were at first thought to be peculiar to this form, although now known to be common to the entire group), which appears to be distinguished from all its relatives by the weakness of its dentition, the teeth being reduced to a small number, of the size and form of lead pencils, confined to the front of the jaws. Another remarkable feature, which may, however, have been common to other members of the group, is the position of the nasal aperture at the top of the skull, this being not improbably indicative of partially aquatic habits, an inference confirmed by the nature of the dentition of Diplodocus, which can scarcely have been adapted for anything else than a diet of soft and luscious water-plants.

Diplodocus was apparently one of the largest representatives of the group, the length of the skeleton, as mounted, being about 75 feet, while if the vertebral column were placed in a straight line the length would be some 10 feet more. The height at the shoulder is about 14 feet. The only rival to such bulk at the present day is presented by the skeleton of Sibbald's rorqual. That such a monster should have a skull considerably smaller than that of a large crocodile is one of the most remarkable facts made apparent by this restoration; while scarcely less noteworthy are the extreme elongation of the neck and tail (the latter for several feet of its length being comparable to a huge whip-lash), and the shortness of the trunk. With the exception of the bones regarded as the clavicles, of which only one original specimen was found, and the position of which in the skeleton may be doubtful, there is full authority for every bone in the model; so that we are now practically as well acquainted with the osteology of these monsters as we are with that of crocodiles.

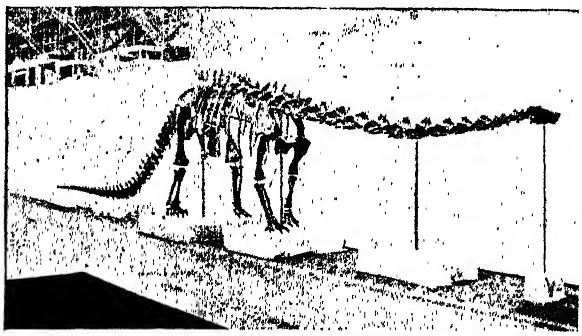

FIG. 1.—Restored Model of the Skeleton of *Diplodocus carnegii* as originally set up in the Museum at Pittsburg. From a photograph presented by Dr. Holland to the British Museum.

Mr. Carnegie's gift, which is due to the initiation of the King, is not only of immense value and interest to the man of science, but will likewise prove a great attraction to the ordinary visitor to the Museum. It is almost an appalling thought that the skeleton of a creature which lived at least several million years ago should have come down in such marvellous preservation to our own day.

THE MASAI OF EAST AFRICA.[1]

THE Masai (the word should be pronounced with a stress on the first syllable—Másai) were first distinguished and described as an East African people by the missionary Krapf, who, with Rebmann, was the discoverer of Mounts Kenia and Kilimanjaro. Krapf, who commenced the exploration of equatorial East Africa in 1848, had begun dimly to perceive the remarkable oneness in language of the Bantu tribes in the southern half of Africa from the Equator to Natal and Cape Colony, and he was therefore puzzled to find in the Masai a race intruding into Bantu East Africa which spoke a language absolutely different from the Bantu type.

At this period—let us say about 1850—the Masai had forced themselves on the attention of the Arab rulers of East Africa by their raids on the cattle of the Bantu tribes, raids which brought them occasionally to within sight of the island-town of Mombasa. In the 'fifties of the last century, nevertheless, the Masai had not established that reign of terror which during the 'sixties, 'seventies, and 'eighties did so much to obstruct the exploration of eastern equatorial Africa, and so long prevented the white man from travelling direct from the Mombasa coast to the eastern shores of the Victoria Nyanza. Therefore, in the 'fifties of the nineteenth century, Swahili, Arab or Baluch traders managed to reach the east and north-east coasts of the Victoria Nyanza from Mombasa or Lamu. The stories they told to Krapf and other missionaries gave to Europeans the first hint of the existence beyond the Masai of tribes allied in speech and physical characteristics and habits. During the 'seventies the Masai pushed their raids further and further south, until they were almost heard of—so to speak—in the regions immediately to the north of Lake Nyasa. In this direction they were ultimately checked by the sturdy resistance of the Bantu Hehe people, a vigorous race that long resisted German dominion in the same territory, a race made more warlike and coherent by a slight infusion of Zulu immigrants from the south. To the south-west the Masai were checked by the warlike Wagogo, to the west by the distantly allied tribes of Lumbwa and Ja-luo, and to the north by the Galas and Somalis. It is possible, however, that but for the eventual interposition of the European they might have

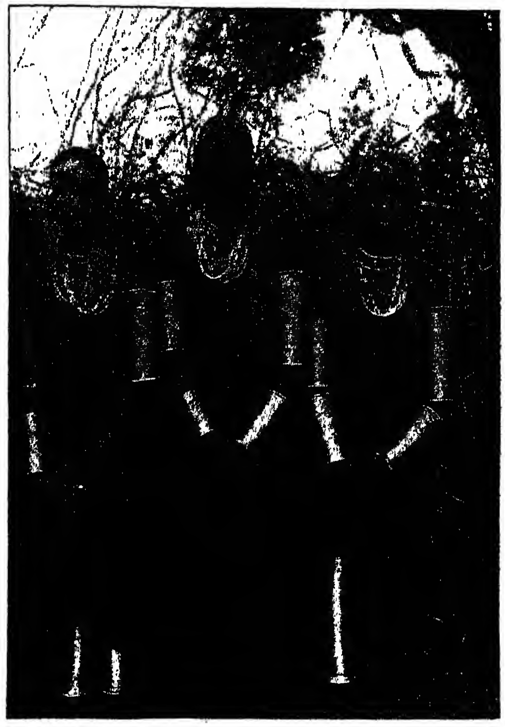

FIG. 1.—Masai girls, showing ornaments. From Hollis's "The Masai."

[1] "The Masai, their Language and Folklore." By A. C. Hollis. With an introduction by Sir Charles Elliot. Pp. xxviii+356. (Oxford: Clarendon Press, 1905.) Price 14s. net.

subdued the Bantu coast people and the Arab half-breeds to the shores of the Indian Ocean.

All observers of the Masai have noted their superiority in physical appearance to the pure-blooded negro. There has evidently been a good deal of intermixture, especially during the last three decades, with women of Bantu race, and the original Masai stock itself is only one of the many hybrids between the Caucasian and the negro; but still the average man or woman of Masai race is a negroid rather than a negro, with a skin of coppery-brown, not black,[1] with a more defined bridge to the nose and a better developed chin than the ordinary negro possesses. They are, however, far more negro in appearance than, for example, the Hamitic (Hima) aristocracy of the lands lying to the north, west and south of the Victoria Nyanza; yet they retain a larger infusion of Caucasian blood (due, of course, to Hamitic intermixture) than the pure type of Nilotic negro, to which in other respects they are nearest allied in origin, language, and, above all, in habits and customs.

FIG. 2.—Masai warriors of various "ages" and "districts," each with the shield of his "age" and "district." From Hollis's "The Masai."

Now that our knowledge of eastern equatorial Africa is so extensive, we realise that the Masai are no isolated phenomenon in racial distribution, but are simply a southward extension of the Nilotic peoples. They probably originated several hundred years ago in the northern part of the present Uganda Protectorate, in the mountainous country between the present abode of the Lotuka tribe (the nearest allies of the Masai in language) and the Turkana peoples to the east. In this region they were simply one of the many blends between the Hamitic (Gala) invaders of equatorial Africa and the Nile negroes. The writer of this review, in his work on the Uganda Protectorate (p. 841), has computed that the proportion of Caucasian intermixture in the case of the Masai is from one-quarter to one-eighth. Their language, which for classification may be grouped with the Lotuka, Elgumi or Wamia, Bari (on the White Nile), Karamojo, and Turkana, is, together with the nearly allied group of the Nandi-Dorobo, distinctly, though distantly, related to the well marked Nilotic family of negro languages which includes the Dinka, Shiluk, Dyur, Acholi, &c., and links on to the negro languages stretching away to Wadai and Lake Chad. In the Masai language, as in the kindred tongues of the Masai group, there is distinct evidence of Somali or Gala influence. This may be due to the ancient intermixture of blood between the Gala and the Nilotic negro which formed the Masai, and also to the contiguity of the Masai in some of their wanderings with outlying groups of Hamitic people.

For the first time the civilised world has been presented with an authoritative work on the Masai language, customs, and folklore, by Mr. A. C. Hollis, of the British East Africa Protectorate. Nothing of the kind worth serious notice has appeared since the works of Krapf and Erhardt. Though a Masai dictionary remains to be composed which shall give a full vocabulary of this interesting language, the book under review can scarcely be bettered in fulness or correctness as a grammatical study. Equally admirable is the collection of Masai legends. These are not given in the form of generalised "stories" with a Hans Andersen flavour; but the original is first of all presented in the Masai with an interlinear translation, and then follows a correct but more readable version in colloquial English. Of necessity, a work like this is more interesting to students than to the general public (though it is admirably illustrated with appropriate photographs). But for the students of African ethnology and languages it is a work of permanent value; it is *the* authoritative study of the Masai people; and it is satisfactory to record that the author confines himself mainly to facts and not to theories, and that Sir Charles Eliot in his introduction does not trace the origin of the Masai to the ten lost tribes of Israel. A recrudescence of this irritating mania having recently appeared amongst German writers on Africa who ought to have known better, it is a relief to find that English authorities on African questions can still retain their sanity on the subject of the proper place in history and ethnology of that mixed Armenian, Dravidian, and Semitic people which we call by the racial name of Jew.

H. H. JOHNSTON.

[1] Owing to their habit of smearing their bodies with a red clay, they strike the casual observer as being a red-skinned rather than a brown race.

NOTES.

THE anniversary dinner of the Royal Geographical Society on Monday was really a complimentary banquet to Sir Clements Markham, the popular and active president of the society, who has just retired from office after twelve years of zealous service. During this period Sir Clements Markham has watched over the affairs of the society, and has guarded the interests of geography, with a devotion

and untiring energy which it is easier to admire than to emulate. But his influence has not only been exerted while directing the affairs of the society as president, for he was honorary secretary of the society from 1863 to 1888, and the Founder's medal awarded to him upon his retirement was a mark of appreciation of his work for the promotion of geography, both in connection with the society and otherwise. It is, indeed, difficult to think of the Royal Geographical Society apart from the personality of Sir Clements Markham, for in all the affairs of the society he has long been ubiquitous. Wherever and whenever geographical interests could be advanced, he has championed them with a strength of view and courage of conviction which have commanded the admiration even of those who have differed from him. He has always been jealous of the honour of his charge; and only those who have been closely associated with him can appreciate adequately how carefully he has cherished the society's welfare. At the banquet on Monday, the chairman, Sir George D. T. Goldie, who has succeeded Sir Clements Markham in the presidential chair, referred in eloquent terms to Sir Clements' work as explorer and author, and his great achievement in the introduction of the cultivation of the Cinchona plant from South America into India. Messages of regret upon the retirement of Sir Clements Markham were read from the King and the Prince of Wales. After Sir Clements had replied to the toast of his health, a testimonial was presented to him from the relatives of the officers and members of the scientific staff of the *Discovery* in recognition of his courtesy in keeping up communication with them. This souvenir consisted of a reproduction of the Cashel cup, and bore a suitable inscription. There was also a gold pin studded with jewels for Lady Markham.

MM. METSCHNIKOFF and ROUX, who have recently shown that syphilis is inoculable on the higher apes, at a meeting of the French Academy of Medicine on May 16 announced that they have at last detected the microorganism of this disease. The microbe appears to be a long, delicate, spirillar form, difficult to observe, and readily destroyed by any manipulations. It seems to have been seen first by MM. Bordet and Gengou, of the Pasteur Institute, three years ago, and subsequently by Herren Schaudinn and Hoffmann, by whom it was named *Spirochaete pallida*. It measures 4–14 μ in length by 1 μ in breadth, and though resembling similar organisms in mucus, &c., is readily distinguished from these. The spirochæte has been found in four out of six human cases of the disease, and also in the inoculated monkeys, and Dr. Levaditi also exhibited preparations of it obtained from a child suffering from hereditary syphilis.

THE Royal Medical and Chirurgical Society celebrated the centenary of its foundation by a dinner on May 22, which was attended by the Prince of Wales and a large and distinguished company, the president, Sir Douglas Powell, Bart., presiding. In responding to the loyal toasts, the Prince of Wales (who is an honorary Fellow of the Society) expressed his pleasure at being present. He regarded his position as president of King Edward's Hospital Fund as a precious trust, and he watched with keen interest and satisfaction the gradual but steady development of medical science. He congratulated the Society on celebrating the 100th anniversary of its foundation, a period which had been prolific in advances in medicine and surgery. Physiology had become established as a precise branch of learning; bacteriology had laid bare the foundations of disease; antiseptics and the clinical thermometer had been invented; our hospitals had become institutions in which the most beneficent treatment is carried out with scientific thoroughness; and in the sphere of public hygiene nothing short of a revolution had been effected. Among the guests were the Duke of Northumberland, Lord Strathcona, Lord Alverstone, Sir W. Huggins, P.R.S., Mr. John Tweedy, P.R.C.S., Surgeon-General Keogh, Prof. Ray Lankester, Sir W. Ramsay, Sir F. Treves, Sir P. Manson, Prof. Christian Bohr, Prof. Pierre Marie, and many others. Last night the Fellows and their friends and other guests were entertained at a soirée at the Natural History Museum. As a fitting supplement to the centenary festivities, it may be mentioned that the society recently invited delegates from the other medical societies to confer on the practicability of an amalgamation between the various societies and the foundation of an "Academy of Medicine," such as exists in Paris and other cities.

IN connection with the fiftieth anniversary of the Société des Sciences naturelles de Lucerne, which takes place this year, the Société helvétique des Sciences naturelles will hold its eighty-eighth annual meeting at Lucerne on September 10 to 13 inclusive. The business of the meeting will be carried on in seven sections, dealing respectively with mineralogy and geology, botany, zoology, chemistry, physics and mathematics, medicine, and civil engineering. Lectures to the general assemblies have been promised by Profs. F. Zschokke, A. Heim, and H. Bachmann. Five scientific societies will hold their annual meetings at Lucerne on the same occasion, namely, the Swiss societies of geology, botany, zoology, and chemistry, and the Zurich Physical Society. Full particulars can be obtained by writing to the president of the meeting, Dr. E. Schumacher-Kopp, Adligenschwylerstr., 24, Lucerne.

IN commemoration of the first admission of women to the full fellowship of the Linnean Society, a dinner was given to the lady fellows of the society on May 18, at the invitation of the treasurer, Mr. F. Crisp.

MR. A. HOWARD has been appointed by the Secretary of State for India economic botanist to the Imperial Department of Agriculture of India. He will be stationed at the experiment station at Pusa, Behar, Bengal.

A COURSE of instruction in oceanic research will be held at Bergen, during the university vacation, from August 8 to October 14. The course, as in previous years, will consist of lectures, practical instruction and assistance in laboratory work; excursions will also be made, during which the use of various appliances and instruments will be practically demonstrated. The work will be in charge of Dr. A. Appellöf, Dr. D. Damas, Dr. H. H. Gran, Mr. B. Helland-Hansen, Dr. Johan Hjort, and Mr. C. F. Kolderup. Further particulars can be obtained from the Oceanographical Institute of Bergen Museum, Bergen, Norway.

THE association which maintains an American woman's table in Dr. Dohrn's marine laboratory at Naples also offers at stated times a cash prize of 200*l.* for the best thesis presented by a woman of any nationality embodying original laboratory research. This prize was awarded at the annual meeting in Boston, on April 29, to Miss N. M. Stevens for a paper on the germ cells of *Aphis rosea* and *Aphis oenothera*. The theses offered in competition for the next prize should be presented to the executive committee of the association, and must be in the hands of the chairman of the committee on the prize, Mrs. Ellen H. Richards, Massachusetts Institute of

Technology, Boston, Mass., before December 31, 1906. The prize will be awarded at the annual meeting in April, 1907.

AT the meeting of the Pathological Society of London on May 16, Mr. C. Walker gave a demonstration which seems to solve the nature of the so-called "cancer bodies" (Ruffer's bodies) of malignant tumours, which have been believed by many to be parasitic protozoa. He showed specimens of the normal reproductive cells of the testis containing bodies which are apparently identical with the "cancer bodies," but are really the archoplastic vesicles of those cells.

IN the *Bulletin of the Johns Hopkins Hospital* for April (xvi., No. 169) the most interesting and important communication is by Dr. Clowes on the immunisation of mice against cancer. In certain mice which had been inoculated with mouse cancer, the disease underwent an unexpected and spontaneous retrogression, and it was found that the serum of these animals produced a marked curative effect on the cancerous tumours in other mice suffering from the disease.

DR. W. B. WHERRY records some interesting observations on the biology of the cholera spirillum (*Bull. Bureau of Gov. Laboratories, Manila*, No. 19), in which he shows that the slight variations in cultural and other characters so often met with in different strains of this micro-organism are largely due to slight differences in the culture media employed, particularly in their reaction, and suggestions are given for the more accurate preparation of standard media.

THE *Journal of the Royal Sanitary Institute* (xxvi., No. 4) contains a report of a discussion on the aërial dissemination of small-pox round small-pox hospitals, in the course of which Dr. H. E. Armstrong, Dr. T. M. Clayton, and others adduce a good deal of evidence against the commonly accepted view of the danger of aërial infection in the neighbourhood of such hospitals. Municipal milk depôts and milk sterilisation is the subject of another paper by Dr. G. F. McCleary.

DR. CHARLES CREIGHTON, who recently paid a special visit to India for the purpose of inquiring on the spot into some of the circumstances connected with the prevalence of plague, read a paper on this disease before the Society of Arts on May 18. Dr. Creighton first criticised the composition of the British Plague Commission of 1898, complaining that there was no epidemiologist upon it. He next gave a somewhat detailed account of the geographical distribution of plague, and directed attention to the difference of incidence of the disease in the villages of the district of Ratnagiri and those of the adjoining district of Satara. In the former all the buildings, roadways, &c., are of stone, and plague occurs little or not at all; in the latter the villages are plague-stricken, and the crowded dwellings are of mud, the floors, &c., being saturated with offal. Dr. Creighton believes that crowded sites too long inhabited and without drainage are the cause of the trouble, which is explicable on the laws of soil-infection enunciated by Pettenkofer and his school.

A PRICED catalogue of pinned specimens of Lepidoptera, issued by Mr. H. Fruhstorfer, of Turmstrasse, Berlin, from whom we have received a copy, should prove useful to collectors.

AMONG our weekly budget are included three papers on North American zoology. In the first, from the *Bulletin of the Brockly Institute* (vol. i., No. 5), published by the Macmillan Company, Dr. J. A. Allan gives a list of mammals from Beaver county, Utah, several of which are described as new. The mammals of this elevated region are stated to differ considerably from their representatives in the adjacent foot-hills. In No. 6 of the same serial Mr. C. Schæfer describes new American beetles, and in the third paper (from the *Proceedings of the U.S. Museum*) Mr. W. D. Kearfoot diagnoses new tortricine moths from Carolina.

IN the April issue (vol. i., part iv.) of the *Records of the Albany Museum* Dr. R. Broom discusses the proper signification of the Owenian term "Anomodontia," and comes to the conclusion that it is applicable only to the dicynodonts. He also describes certain new fossil reptiles from Aliwal North, and contributes some important notes on the localities of type specimens of other South African reptiles, especially those in the British Museum. In the course of these remarks, it is pointed out that Anthodon is of Wealden age, and probably, therefore, a dinosaur instead of a pariasaurian, and that the limb-bones described by Owen as Platypodosaurus are almost certainly referable to Udenodon.

IN the issue of *Biologisches Centralblatt* of May 1 the Rev. Father Wasmann brings to a close his important series of articles as to the origin of slavery among ants, and formulates the conclusions at which he has arrived, which are too long to be recapitulated in our columns at length. It may be mentioned, however, that, in the author's opinion, this system of slavery had independent origins at different dates respectively in the formicine and the myrmecine sections of the ant family, and that it has also been independently acquired in different genera and species of these two subfamilies at different times. In general, it seems to have been of later origin in the Formicinæ than in the Myrmecinæ. Moreover, the phenomenon affords confirmation of the biological doctrine that the ontogeny of a group constitutes a brief recapitulation of its phylogeny. In another article in the same issue Dr. O. Zacharias emphasises the importance of modern methods of studying "hydrobiology" in relation to fish-culture and fisheries.

PART iii. of vol. xlvii. of the quarterly issue of *Smithsonian Miscellaneous Contributions* contains an article by Mr. C. D. Sherborn on the species of birds described as new in Vroeg's catalogue, published in 1764. P. S. Pallas is believed to be the real author of the names. The only copy of this work that has come under the author's notice is in the library of the Linnean Society, where it might have been left in well merited obscurity. Social spiders (*Stegodyphus sarasinorum*) form the subject of another article, by Mr. N. S. Jambunathan, in the same serial. The spiders of this species, which was discovered by the author at Saidapet, Madras, in 1898, live in a sponge-like nest formed of branching net-work with communicating canals and a number of external openings. These nests, which may be attached either to the tips of branches of trees or to leaves of the prickly pear, are ashy-grey in colour, and constructed of leaves and refuse from the spiders' food. Externally is a coat of stout sticky threads of the same colour as the spiders themselves, and sheet-like webs spread in all directions from the nests. Five or six nests are often found together, each of which may be the home of from 40 to 100 spiders, usually in the proportion of seven males to one female. A number of spiders will cooperate to overpower a single large insect.

DURING the last few days paragraphs have appeared in the newspapers stating that a plague of flies has invaded Cardiff Docks, causing much inconvenience. The flies are said to have made their appearance with a southerly wind on Sunday, May 14. Mr. Ernest E. Austen, of the British Museum (Natural History), informs us that specimens forwarded to the museum show that the trouble has been caused by the fly known as *Dilophus febrilis*, Linn., a very common British species of the family Bibionidæ, met with from April to September, but especially abundant in May. In colour the flies are black, with a shining thorax, and measure about $5\frac{1}{2}$ millimetres, or rather less than a quarter of an inch, in length. As in all Bibionidæ, the males are distinguished from the females by the large size of the head, which in the former sex appears from above to be entirely composed of the eyes. Of five specimens sent to the British Museum, all were males. *Dilophus febrilis* breeds in horse and cattle droppings, in which the larvæ—white footless grubs measuring half an inch in length, with a dark brown head capsule at the anterior extremity—are found in small masses. This fly is quite incapable of biting, as are also all the other species of the same family, so far as at present known, though the possession of an elongated proboscis by two Mexican representatives of the genus Plecia suggests that there may be forms that suck blood. The occasional occurrence of Bibionidæ and other Diptera in immense numbers is well known, and notes on the subject have already appeared in these columns (*cf.* NATURE, vol. xlviii., 1893, pp. 103, 127, 176). With regard to *Dilophus febrilis*, Mr. J. W. Douglas, writing in the *Entomologist's Monthly Magazine* for 1880 (p. 142), describes a swarm of this species at sea off the Norfolk coast on September 2 of that year. It is stated that the air was obscured by the flies as by a cloud, and that a schooner sailing at about a cable's length from the shore was so covered with them that for five hours persons were unable to remain on deck; the air cleared at about 4 p.m. The cause of these phenomenal swarms is still uncertain, but it is probably to be found in exceptionally favourable climatic conditions, which, by accelerating the growth of the larvæ and shortening the pupal stage, cause myriads of flies to appear at practically the same time.

IN the *Biological Bulletin* (February) Mr. R. S. Lillie discusses the conditions determining the disposition of the chromatic filaments and chromosomes in mitosis, and advances a physicochemical theory, based upon mutual repulsions of the particles of a colloid solution, to explain the sequence of the stages in nuclear division.

A REVISION by Mr. B. Hayata of the Euphorbiaceæ and Buxaceæ of Japan, as represented in the herbarium of the University of Tokio, forms article iii. in vol. xx. of the Journal of the College of Science in that university. The number of genera is limited to twenty-four under Euphorbiaceæ and two under Buxaceæ, and seven new species are recorded. The author has provided figures of the flowers for most of the species.

A BRIEF survey of the progress of the Nilambur Teak Plantations, Madras, from its inception by Mr. Conolly in 1840 to its present condition, when the receipts more than balance the cost, is contributed by Mr. R. McIntosh to the *Indian Forester* (March). The harvest time is still thirty-five years ahead, when the fellings are expected to produce a revenue of 40,000*l*. a year. The difficulty experienced at first in getting the seed to germinate was overcome by soaking the seeds before planting, and by keeping the soil thoroughly moist after planting. The teak forests of Burma form the subject of another article, in which Mr. R. S. Troup comes to the conclusion that useful as fire protection may be in most forests, annual burning in moist mixed forests of teak and bamboos is decidedly efficacious.

THE appearance of a *Nature-study Review*, edited and published by Mr. M. A. Bigelow in Lancaster, Pennsylvania, indicates that the subject is making progress in the United States. A discussion in the first number as to the scope of nature-study has led to a general expression of opinion that it differs from natural science in so far as it lacks the characteristic organisation of science, and that it should be confined to elementary schools; further articles on the subject appear in the March number, which is the second of a bi-monthly issue. Amongst the articles giving the experiences of teachers one by Dr. E. A. Bigelow directs attention to the convenience of putting up the salts required for plant food solutions in tabloid form.

IN *Spelunca* (*Bull. de la Soc. de Spéléologie*, tome v., Nos. 39 and 40) there are interesting articles on the caverns and subterranean water-courses of the Mendip Hills, by Mr. H. E. Balch, and on those of the Jura Mountains by M. E. Fournier.

MR. E. C. DAVEY, who in 1874 contributed to the *Transactions of the Newbury District Field Club* an essay on the sponge-gravel beds near Faringdon, with photographs of some of the fossil sponges, has revised and amplified his article under the title "The Neocomian Sponges, Bryozoa, Foraminifera, and other Fossils of the Sponge-gravel Beds at Little Coxwell, near Faringdon." This is now published by Messrs. Dulau and Co., price 5*s*. net, and it contains five photographic plates of sponges, Echini, and Foraminifera. The nomenclature of the sponges is revised in accordance with the researches of Dr. G. J. Hinde, but the author does not wholly agree with the determinations made by that palæontologist, and adds other species, one new species being figured and briefly described. Under the heading "Bivalves," the author includes brachiopods and lamellibranchs; he makes no reference to the occurrence of Belemnites, to which Mr. G. W. Lamplugh directed special attention in 1903 (*Geol. Mag.*, p. 32).

BASING his conclusions largely on the capacity of the cranium, but also taking into account other characters, Mr. A. da Costa Ferreira has attempted to dissect out, as it were, the probable racial constituents of the Portuguese, and has set forth his results in the *Bulletin de la Société d'Anthropologie de Paris* (5e. sér., tome v., p. 473). He finds a short, mesorhine dolichocephalic type with a small head which he thinks belongs to the Cro-Magnon race, and a tall, leptorhine dolichocephalic type with a large head. The mesaticephals are partly attributed to a brachycephalic mixture; those of short stature, leptorhine, and with a large head, are thought to belong to the race of Grenelle or to a Celtic invasion. The small headed, leptorhine mesaticephals are probably of Semitic origin, while the mesorhines may be of Berber extraction.

IN order to make more widely known and more easily accessible to American students the results of important researches on the Maya hieroglyphs, printed in the German language, the Peabody Museum Committee on Central American Research has begun a series of translations of which the first, on the representation of deities of the Maya manuscripts, by Dr. P. Schellhas, has been published as vol. iv., No. 1, of the *Papers of the Peabody*

Museum, Harvard University. In this valuable enumeration Dr. Schellhas is very careful not to theorise or to go beyond the warrant of the manuscripts themselves. In several cases he refers to diverse views concerning the names of the gods in question; but, as he truly observes, "these different opinions show on what uncertain grounds such attempts at interpretation stand, and that it is best to be satisfied with designating the deities by letters and collecting material for their purely descriptive designation. In vol. iii. of the same *Papers* are illustrated accounts of the Cahokia and surrounding mound groups, by Mr. D. I. Bushnell, and of the exploration of mounds in Coahoma, co. Mississippi, by C. Peabody. In vol. i. Mrs. Zelia Nuttall gives a very interesting account of a penitential rite of the ancient Mexicans mainly derived from Spanish sources. Blood was drawn from cuts in various parts of the body, including the tongue and ears; the rite of voluntarily drawing blood, principally from the ear, was a feature of every-day life in ancient Mexico, and was performed by young and old. It constituted an act of humility, thanksgiving, penitence, or propitiation.

THE Survey Department of Egypt has published an important paper on the rainfall of the Nile basin in 1904, by Captain H. G. Lyons, director-general of the service. Five years ago there were only six or eight places where the rainfall was being measured regularly; now, thanks chiefly to the efforts of Captain Lyons, there are more than forty, of which thirty-two lie to the south of Berber (lat. 18° N.). He points out that to understand the seasonal variation of the rainfall the relative positions of the equatorial low-pressure belt, and the high-pressure areas to the north and south of it at different seasons, must be taken into consideration. In the low-pressure area there is an ascensional movement of the air, so that its moisture is condensed to form clouds and rain. This ascensional movement depends upon the heating effect of the sun, and it is shown month by month how the low-pressure area varies with respect to the sun's position from south to north, and back to south again. The carefully prepared tables and diagrams show, as a general result, that the rainfall of 1904 in the Nile basin was below the average; in the equatorial regions it was somewhat deficient in the earlier part of the year, and above the average in the autumn.

A SOMEWHAT striking paper has been published by Prof. Ronald Ross, F.R.S., of Liverpool University, on verb functions, with notes on the solution of equations by operative division (*Proceedings of the Royal Irish Academy*, xxv., A, 3). The writer points out that whereas symbols such as f and ϕ are used to denote functions in general, no notation exists which can explicitly represent the operation of forming any *particular* function of any argument, apart from the argument itself, except in certain simple cases as exemplified by the prefixes log, sin, &c. The notation proposed by Prof. Ross meets this want. It depends on the use of a purely symbolical letter β to denote the *base* of a given operation, this symbol occurring in the "verb function" or operator. When this verb function operates on a subject x, it produces the result obtained by writing x for β in the operator. For example,

$$[\beta^{m/n}](ab)=(ab)^{m/n}, [\beta \log \beta - 1]x = x \log x - 1, [\epsilon^{\beta} \cos \beta]x = \epsilon^{x} \cos x,$$

and so on. Another peculiarity is the use of square brackets to enclose each separate operation, the necessity of which may be illustrated by the following example:—
$[(a+\beta)^2]x$ represents $(a+x)^2$, whereas

$$[a+\beta]^2x=[a+\beta][a+\beta]x=[a+\beta](a+x)=a+(a+x)=2a+x.$$

In connection with inverse operations, Prof. Ross introduces the notation of a double fraction or solidus line as a distinction from the ordinary division symbol; thus, according to his notation, we should have

$$\frac{1}{[a\beta^2+b\beta+c]}0 = -\frac{b \pm \sqrt{(b^2-4ac)}}{2a}$$

as the symbolical enunciation of the expressions for the roots of a quadratic equation.

THE peculiar magnetic properties of the so-called Heusler's bronzes, consisting of copper, manganese, and aluminium, are the subject of a paper by E. Take in the *Verhandlungen* of the German Physical Society (vol. vii., 133). The "transformation points" of a number of samples of the bronze were determined, as well as the effect of heating and re-heating upon them. The results are shown in a series of striking curves.

REFERENCE has already been made in these notes (NATURE, vol. lxx. p. 583) to the simple form of telescope pyrometer invented by M. Féry for measuring high temperatures. This instrument is now being sold by the Cambridge Scientific Instrument Co., Ltd., who have been appointed sole agents for its sale in the United Kingdom, the British colonies, and in the United States; it is made in two forms, a mirror pyrometer, recording temperatures between 500° C. and 1100° C., and a lens pyrometer, reading between 900° C. and 3500° C.

PROF. MOISSAN has published, in the form of a pamphlet having the title "La Chimie minérale, ses Relations avec les autres Sciences," an address delivered last September at the Congress of Arts and Sciences at St. Louis. Prof. Moissan, who by his own researches and those of his colleagues has so widely enlarged the domains of inorganic chemistry, whilst regretting that this branch of science is still systematically imperfect as compared with organic chemistry, emphasises the fact that during the past few years its study has again resumed a place of honour. This has been due largely to the discovery of the gases of the atmosphere, to research at high and low temperatures, the investigation of the rare earths, and to the increasing tendency to the fusion of chemical and physical methods. "Many important investigations still remain to be made in inorganic chemistry, but for success very refined methods and a high degree of accuracy will be required. Chemical research must acquire the precision of physics." Finally, it must be recognised that experiment is the sole guide to truth, and that Faraday's saying still holds true that chemistry is essentially an experimental science.

THE recent researches of M. Berthelot on the permeability of fused quartz vessels to gases at high temperatures have led him to study glass from the same point of view, with very interesting results. In many analytical processes, and more especially in the analysis of organic compounds, it is tacitly assumed that at temperatures below its melting point glass is impermeable to oxygen, nitrogen, and carbon monoxide and dioxide. In the current number of the *Comptes rendus*, M. Berthelot gives an account of some experiments on glass, the mode of working being the same as that used for the quartz tubes (see NATURE, April 13, p. 568) with the exception that the tubes were necessarily slowly cooled, and finds that at temperatures between 550° C. and 800° C. glass tubes are permeable to gases. He compares the passage of gases through slightly softened glass to the gaseous exchanges taking place at the ordinary temperature through the walls of indiarubber tubing, and emphasises the importance of this property of glass, hitherto unsuspected, in many chemical and physical investigations at high temperatures.

MESSRS. CROSBY LOCKWOOD AND SON will publish shortly a work on "Modern Lightning Conductors," by Mr. Killingworth Hedges, honorary secretary of the Lightning Research Committee.

AN appendix to Mr. R. L. Taylor's "Student's Chemistry" has been published by Mr. John Heywood. It consists of two sections; the first part deals with the radio-active elements, and the second is an introduction to the study of organic chemistry.

WE have received from the Art. Institut Orell Füssli, of Zurich, Nos. 177, 178, and 179 of their "Illustrated Europe" series of handbooks. The three parts are bound together in a convenient little volume with the title "Grisons Oberland." The guide book is by Dr. Chr. Tarnuzzer, and a historical sketch has been contributed by Prof. J. C. Muoth. The translation into English was done by Dr. and Mrs. Spöndly-Blakiston. Visitors to this interesting part of Switzerland will find interesting scientific, historical, and topographical information in this guide book. The book may be obtained in this country from Messrs. Hachette and Co.

MESSRS. OLIVER AND BOYD have published the ninth volume of the "Reports from the Laboratory of the Royal College of Physicians, Edinburgh." The volume is edited by Sir J. B. Tuke and Dr. Noël Paton. The papers included fall under two categories; the first comprises fourteen papers describing researches on the ductless glands under the Mason fund, and the second consists of general researches in physiology, pathology, and pharmacology.

WE have received from Mr. John Grant, of Edinburgh, a catalogue of scientific books, chiefly on botany, zoology, and geology, and a catalogue of recent purchases—including some well known works of science—all of which are offered at greatly reduced prices.

MR. W. BUTLER, Southport, has devised a new type of camera stand—called the Swingcam—to facilitate the photography of natural history subjects. The stand enables a photographer to point the lens of a camera at any angle and fix it in that position, without the use of a swinging back or front or any other independent attachment. The Swingcam tripod head can be fixed in a horizontal or vertical position, or at any angle, and is also capable of being inverted if desired. Naturalists and others who occasionally have to use cameras in awkward positions will no doubt find these devices a convenience.

NEW editions of two standard works already reviewed in these columns have just been received from Mr. Gustav Fischer, Jena. One is the seventh edition of the "Lehrbuch der Botanik" by Profs. Strasburger, Noll, Schenck and Karsten, and the other is the seventh edition of Dr. R. Hertwig's "Lehrbuch der Zoologie." Both works have been revised, so that they will maintain their high position among text-books of science.

WE have received from Messrs. Henry Sotheran and Co., 140 Strand, W.C., a copy of their latest catalogue of second-hand books, including numerous scientific works; and from Messrs. John Wheldon and Co., 30 Great Queen Street, W.C., a catalogue of a miscellaneous collection of books, comprising many dealing with biology, geology, and mathematics.

MESSRS. DAWBARN AND WARD, LTD., have published a second revised edition of "Photographic Failures: Prevention and Cure," by "Scrutator" of the *Photogram*.

OUR ASTRONOMICAL COLUMN.

NEWLY DISCOVERED NEBULÆ.—In No. 4013 of the *Astronomische Nachrichten* Prof. Max Wolf announces the discovery of a small, but beautiful, nebula the position of which, referred to the equator of 1900·0, is as follows:— $\alpha = 13h.\ 58m.\ 33{\cdot}44s.$, $\delta = -9^\circ\ 39'\ 36''$. This object was discovered on a plate exposed during a search for minor planet (126), Velleda, and is of a spiral form, of the unusual S-shaped variety, the nucleus being of the fourteenth magnitude. Its diameter in R.A. is about $0'{\cdot}75$, and in dec. about $1'{\cdot}0$.

A second nebula of especial interest was found in the position (1900·0) R.A. $= 13h.\ 58m.\ 15{\cdot}17s.$, $\delta = -9^\circ\ 40'\ 10''$. This object is $1'$ in length along its major axis, which has a position angle of about 120°, and is of the Andromeda nebula form.

THE BRUCE TELESCOPE REFERENCE PHOTOGRAPHS.—When the 24-inch Bruce telescope of the Harvard College Observatory was being planned it was expected that the instrument might be useful in assisting in the discoveries of new satellites, and this expectation was realised in the discovery of Phœbe. A number of plates of each planet have been taken since 1893, and of these Prof. Pickering now gives the details as to object photographed, exposure, date and region, in Circular No. 97 of the Harvard College Observatory, hoping that the knowledge of their existence may assist other observers of possible satellites. The list includes 12 plates exposed for Mercury, 2 for Mars, 6 for Vesta, 21 for Jupiter, 12 for Uranus, and 3 for Neptune. The Saturn plates were fully described when the manner of the discovery of Phœbe was related in a former publication. The limiting magnitude of the objects shown on these plates may be taken as 17·0 or 17·5, and therefore the photographs may prove useful in the correction of the elements of Jupiter's newly discovered satellites when more is known of the positions of these two objects.

COMET 1904 II. (1904 *d*).—A continuation of the ephemeris for comet 1904 *d* is given in No. 4012 of the *Astronomische Nachrichten* by Herr M. Ebell.

This comet is now only about one-sixth as bright as when discovered, and is gradually becoming fainter. Its position on May 26, according to the ephemeris, will be α (true) $= 2h.\ 23m.\ 48s.$, δ (true) $= +64^\circ\ 50'$, which is about 2° south of ι Cassiopeiæ, and the object is travelling slowly towards the constellation Camelus with a very slightly increasing declination.

TWELVE STARS WITH VARIABLE RADIAL VELOCITIES.—Further results of the spectrographic work performed by the D. O. Mills expedition from Lick Observatory to the southern hemisphere are published in Bulletin No. 75 of that observatory.

Twelve stars have been found by Prof. Wright and Dr. Palmer to be spectroscopic binaries, some of them, mentioned below, having features of especial interest. α Phœnicis has a period of about 190 days. The system of θ Eridani has been found to be very similar to that of Mizar, the brightest component, θ_1, having a composite spectrum similar to that of the star named. α Puppis, α Volantis, α Carinæ, and κ and p Velorum are amongst the other stars of which the radial velocities have been found to be variable.

DOUBLE "CANALS" ON MARS IN 1903.—In Bulletin No. 15 of the Lowell Observatory Mr. Lowell gives, and discusses in detail, the results of his observations of the Martian "canals" during 1903. Before proceeding to the account of the actual observations, he comments on the various theories which have been advanced in argument against the reality of the "doubling" phenomenon. The "diplopic" or out-of-focus theory is refuted for five reasons, the chief of which is that for any special epoch the width of each individual double canal remains constant.

The "interference" theory is met by the statements that in the case of these features there is no bright streak such as would be necessary to produce the two dark streaks to give the idea of a double canal, and that the width of each double canal does not vary with the aperture employed. Lastly, the "illusion," or, as Mr. Lowell refers to it, the "Small Boy," theory is considered,

the chief argument against it being that the ambiguity of real and false effects only exists at the limit of vision, whereas most of the canals considered are, *when well seen*, far within this limit.

A number of interesting points concerning the canal systems are deduced from the 1903 observations, but only one or two of the more striking may be mentioned here. (1) The majority of the double canals do not exceed 3°·2 (degrees on the planet's surface) in width; (2) at the time of maximum visibility the two members of each double are generally of equal strength, but as they wane one of them usually becomes apparently stronger than the other; (3) the double canals appear to congregate in special longitudes and latitudes, in the latter case especially favouring the equatorial regions, a fact which Mr. Lowell urges as an argument against the "diplopic" theory; (4) the double canals are peculiar to the lighter regions of the planet's surface, although single canals are, apparently, just as numerous in the darker as in the lighter regions; the double canals, however, are always connected, directly, or through the medium of similar objects, with the darker areas.

CATALOGUE OF NEW DOUBLE STARS.—Prof. Hussey's ninth catalogue of double stars, discovered with the 12-inch and 36-inch refractors of the Lick Observatory, and mostly measured with the latter instrument, is contained in Bulletin No. 74 of that observatory. The preceding catalogues have severally appeared in Nos. 480, 485, and 494 of the *Astronomical Journal*, and Nos. 12, 21, 27, 57, and 65 of the Lick Observatory Bulletins.

The present publication gives the catalogue and D.M. numbers, the position and the distance and position-angle determined at each observation for each of the double stars recorded. The catalogue numbers extend from 801 to 1000 inclusive, and run consecutively.

THE ROYAL SOCIETY CONVERSAZIONE.

MANY instruments and devices of scientific interest were shown at the Royal Society's conversazione on Wednesday, May 17. As usual, the exhibits illustrated methods and results of recent work in various branches of science, and the subjoined summary of the official catalogue contains a few particulars relating to them.

In the course of the evening lantern demonstrations were given in the meeting-room by Dr. E. A. Wilson, Sir Oliver Lodge, and Mr. Perceval Landon. Sir Oliver Lodge demonstrated the use of electric valves for the production of high-tension continuous current. Electric vacuum valves, which it is now found were suggested in a letter by Sir George Stokes twenty years ago, have as their function the *entrapping* of a portion of electricity by permitting its passage in one direction and stopping its return. They therefore can be employed to accumulate electricity supplied from an intermittent or jerky source and to store it at a steady high potential; so that it may thereafter maintain a current through a very high resistance, as in electrostatics, and may produce X-rays, or point-discharge, or other continuous high-tension effects, and enable a small portable coil to imitate some of the effects of a much larger one by storage and accumulation of impulses. Among the applications contemplated are the separation of metallic fume and the dissipation of fog.—Dr. Edward A. Wilson showed a number of Antarctic views illustrating the life and work done on board the *Discovery* during the years 1902 to 1904, and views of the seals, penguins, and other birds met with in the Antarctic circle; and Mr. Perceval Landon exhibited pictures of the road to Lhasa.

The other exhibits are here grouped together according to subjects more or less closely related to one another.

Specimens illustrating the action of light and of radium upon glass: Sir William Crookes, F.R.S. (1) It is well known that many samples of colourless glass containing manganese slowly assume a violet tint when exposed to sunlight. In some specimens of glass exhibited the pieces were of all depths of tint, from deep violet, almost black in thick pieces, to pale amethyst. Analysis shows the glass to contain manganese. Heating the glass in a covered crucible to its softening point discharges the colour, leaving the glass white and transparent. The coloration is not superficial. On immersing a piece of the coloured glass in a liquid of about the same refractive index as itself, the colour is seen to have penetrated throughout the mass. Radium, acting for a few days, even through quartz, will produce as intense a coloration in a piece of this glass as exposure to the sun on the Pampa has taken years to effect. Six pieces of glass from the greenhouses at Kew Gardens illustrated changes which took probably about fifty years to complete in our climate. Purple spots were produced on two of these specimens by Sir William Crookes by the action of 15 milligrams of radium bromide in a quartz tube in the course of ten days, the beginning of change being well marked at the end of two days. In a specimen of manganese glass exposed to light for forty years as a pane of a greenhouse, the ends of the glass which had been protected from light by the window frame were colourless. In the expectation that radium might have a reducing effect on the manganese compound, Mr. F. Soddy submitted a portion of the pane to the action of 30 milligrams of radium bromide for three days in May, 1904. The colour, however, instead of being diminished, was intensified. Specimens were also shown illustrating the coloration of glass, quartz, and fluorspar by the β rays of radium.

Action of actinium or emanium emanation on a sensitive screen: Sir William Ramsay, K.C.B., F.R.S. Actinium or emanium are different names, adopted by Debierne and Giesel respectively, for the same substance, separable from pitchblende, and accompanying lanthanum. It gives off an emanation, of which the period of activity is very short—a few seconds. When this emanation impinges on a sensitive zinc sulphide screen, the screen becomes luminous. The luminous patch can be blown away, and in a second or two reappears.—Phosphorescence caused by the β rays of radium: Mr. G. T. Beilby. Phosphorescence of calcspar and other substances—(1) during exposure to the rays; (2) after removal from the rays; and (3) revived by heat after secondary phosphorescence has died down. The storage of phosphorescence and the coloration effects are due to partial electrolysis of the calcium carbonate or other substance by the stream of negative electrons. A proportion of the ions re-combine at once, others continue to re-combine after the rays have ceased to act, and the remainder only re-combine when the mobility of the crystal molecules is increased by heat.—Skiagrams of the hands of Machnow, the Russian giant, and of O'Brien, the Irish giant: Mr. S. G. Shattock.

Large echelon spectroscope: Prof. A. Schuster, F.R.S. This echelon spectroscope, constructed by Messrs. Adam Hilger, Ltd., consists of 33 plates, and has a resolving power equal to that of an ordinary grating of 329,000 lines in the first order.—A hand refractometer: Mr. G. F. Herbert Smith. By means of this form of refractometer the refractive indices of any translucent substance, the refractive power of which lies within the effective range of the instrument, 1·400 to 1·760 approximately, may be determined with ease and celerity, to units in the second place of decimals if ordinary light, and to two or three units in the third place of decimals if the monochromatic light emitted by a volatilising sodium salt be the source of illumination.—The Ashe-Finlayson comparascope: Mr. D. Finlayson. This accessory to the microscope has been designed to enable the images of two different objects, separately mounted, to be projected side by side into the field of view, thereby enabling a thorough comparison to be made of their respective points of difference and resemblance. The apparatus consists of a prism placed above the primary objective which reflects to the ocular the rays from a secondary objective placed at right angles to the optic axis of the microscope.—(1) Torsion balance, used in radiation pressure measurements, by Nichols and Hull; (2) vacuum tube, of Nichols and Hull, to illustrate the repulsion of comet tails by the sun: Prof. E. F. Nichols.—An optical appliance to facilitate visual perception of ultra-microscopic particles: Mr. Carl Zeiss. The apparatus consists of a projection table provided with an arc lamp, optical bench, two projection aplanats, and a precision slit. (The use of sunlight instead of the arc lamp is preferable.) Particles of far less than half a wave-length can be made visible with this apparatus.—

Mechanical lantern slide illustrative of the phenomenon of a total solar eclipse: Mr. W. Shackleton. A white disc representing the sun is projected on a screen; by moving an opaque disc representing the moon, this is gradually obscured, and the preliminary partial phases of a total solar eclipse are shown. A moment before complete obscuration a twin shutter is opened, which allows the corona and chromosphere to be projected, thus reproducing totality, which may last as long as desired.—Stereoscopic views of the sun and stars of estimated parallax: Mr. T. E. Heath. The perspective drawings were made from a plan and elevations in which the scale of stellar distances was ten light-years to 1 inch, and of stellar discs such that the sun (or a star which gives equal light) was 1/50th of an inch in diameter. The magnitudes were made to vary with the varying distance of the spectator.—(1) Microscope and goniometer stage for examining the optical qualities of minute grains of sand; (2) set of petrological quartz wedges; (3) photomicrographic camera, designed by Mr. J. W. Gordon for taking small direct photomicrographs while the instrument is in use after observation without attention to the adjustments: Messrs. R. and J. Beck, Ltd.

(1) Photomicrographs of section of gun tube showing change in structure of steel after 2000 rounds; (2) photomicrographs of alloys of aluminium with nickel; (3) photomicrographs of alloy of copper with cobalt and nickel: Dr. Hodgkinson, Captain Playfair, R.A., and Mr. Coote.—(1) Apparatus for polishing and preparing metals for microscopic examination; (2) specimens of steels in the cast and forged condition containing phosphorus: Mr. J. E. Stead, F.R.S.—Transverse sections of slip-bands and other microscopic features of metallic surfaces: Mr. W. Rosenhain.—A series of alloys of iron and steel tested at liquid air temperature: Mr. R. A. Hadfield. The specimens showed the effect of liquid air (temperature $-182°$ C.) upon almost pure iron (Swedish charcoal iron "S.C.I.," 0·04 carbon, 99·82 iron) and a large number of alloys of iron with other elements. The well known ductility of iron disappears, while its tenacity is more than doubled. Similar effects occur with nearly all the alloys of iron with carbon and other elements, except those containing nickel, which metal appears to modify considerably the embrittling effect of low temperatures upon iron.

Clock and chronometer by Thomas Mudge: Mr. A. Mallock, F.R.S. The clock was made about 1776, and contains Mudge's moon motion. Mudge's object in making this motion was to show that any desired velocity ratio could be approximated to very closely with comparatively few wheels. The train of wheel-work he employed makes the mean lunation 0·03 second less than the actual mean lunation, that is, the error is less than 1 in 2½ millions. There are other remarkable features in this clock connected with the balance wheel, escapement, and temperature correction.—(1) Tangent-micrometer for theodolites, &c.; (2) endless-tangent screw for sextants: Mr. E. A. Reeves. By the addition of a micrometer "drum," and a simple arrangement for clamping the outer rim or dial carrying the numbers, combined with a special indicator, a carefully constructed tangent-screw serves also as a micrometer, and renders it possible to read the arc with the same accuracy as with the usual form of micrometer, while the instrument need not be larger than the ordinary vernier theodolite. The sextant device consists of a tangent-screw constructed with an endless thread, by means of which the vernier arm can be made to pass from any one part of the arc to another. For making rough contacts the tangent-screw is raised from the arc by means of a lever pressed by the finger. When the pressure on the lever is released the tangent-screw, actuated by a spring, again comes in contact with the arc, and serves as a clamp.

A direct reading cymometer for measuring the length of the waves used in wireless telegraphy: Prof. J. A. Fleming, F.R.S. The instrument consists of a sliding tubular condenser and an inductance coil, the capacity and inductance being varied together in the same proportion by one movement of a handle. The circuit is closed by a copper bar, which is placed alongside the aërial wire indicating the electric waves. The handle of the cymometer is then moved until a neon vacuum tube used as an indicator shines most brightly, and thus determines when the cymometer circuit is tuned to the frequency of the aërial. A pointer moving over a scale then indicates the wave-length of the radiated wave in feet or metres.—An oscillation valve for rectifying electrical oscillations and rendering them measurable on an ordinary galvanometer: Prof. J. A. Fleming, F.R.S. The valve consists of a bulb enclosing a carbon filament made like an incandescence lamp. The filament is surrounded by a metal cylinder. The bulb is highly exhausted. When the filament is incandescent, negative electricity can move through the vacuum from the hot filament to the cylinder, but not in the reverse direction. Hence the arrangement can separate out the two opposite currents in an electric oscillation. It can be used in combination with a dead beat galvanometer as a receiver in wireless telegraphy. The valve replaces the coherer and other appliances, and the signals are given by long and short deflections of the galvanometer.—(1) Resonance induction coil and high potential apparatus; (2) resonance electromagnet: Messrs. Isenthal and Co. Electrolytic condensers of very large capacity are charged from the mains through the primary of a suitably wound induction coil, and the circuit broken and reversed at zero potential by means of a motor-driven commutator of special construction. The advantages are:—no motor transformer is required in primary circuit, no rectifying device in secondary circuit, and there are no interruptors to be cleaned. The apparatus enables a current to be converted sparklessly into pure sine current suitable for space telegraphy. An electromagnet excited from a source of this kind exhibits peculiar physical and physiological phenomena.—(1) High-tension resonance transformer; (2) X-ray stereoscope: Mr. Russell Wright. The special form of "step-up" transformer exhibited works direct from the alternating current mains, and produces an alternating discharge of sufficient tension for X-ray work or high-frequency effluve. By means of a small revolving shutter, driven by a synchronous motor, between the observer's eye and two X-ray tubes, stereoscopic images could be clearly seen on an X-ray screen.

High temperature electric furnaces: Director of the National Physical Laboratory. These furnaces are constructed of rare earths such as are used in Nernst lamps. They are available for temperatures between 800° C. and 2000° C. The apparatus used in a recent determination of the melting point of platinum was shown at work, in addition to that for other experiments of a similar character.—New models of laboratory electric furnaces: Mr. R. S. Hutton. The furnaces consist of a carbon tube, rod, or plate heated by an electric current. In the tube furnaces the carbon is surrounded by some material of low thermal conductivity, which also serves to protect the hot tube from oxidation. The substance to be heated is placed in a carbon boat or crucible inside the tube, and can thus be brought to a very high temperature. The method employed for conveying the current to the carbon by soldering water-jacketed sleeves to the electro-coppered ends of the carbon forms a novel feature of the construction.

Photographs taken in China by the Carnegie expedition under Mr. Baily Willis in 1904, illustrating a presumably Glacial deposit underlying the base of the Cambrian rocks of the region: Sir Archibald Geikie, Sec.R.S.—Photographs, cast, and model of skull of Diplodocus, a Jurassic dinosaur from Wyoming, and other fossils from the middle west of North America: Dr. W. J. Holland.—Remains of fossil mammals from Crete: Miss D. M. A. Bate. Numerous mammalian remains were found in 1904 in the Pleistocene cave and fresh-water deposits of Crete. These include remains of the following animals:—antelope, deer, elephant, pigmy hippopotamus, shrew, and two species of rodents.—The great Indian earthquake, April 4: Prof. J. Milne, F.R.S. Five seismograms of this disturbance were shown from Shide, Isle of Wight. (1–2). Open diagrams on smoked paper showing north-south and east-west motion. (3) Open diagrams of east-west motion on photographic paper. The instrument was a Milne horizontal pendulum. (4–5) Photographic records from a pair of Milne horizontal pendulums vibrated north-south and east-west. The exhibit also included seismograms of east-west

motion from Edinburgh, Paisley, Beirut, and Toronto.—Charts of the Gulf of St. Lawrence, showing the co-tidal lines at mean time of Quebec: Captain Tizard, C.B., F.R.S.—Photographs of the "Cullinan" diamond: Sir William Crookes, F.R.S.

Microscopic preparations illustrating the development of calcareous spicules in various invertebrate animals: Prof. E. A. Minchin and Mr. W. Woodland. Calcareous spicules are small skeletal elements to be found in most of the lower animals. These spicules assume varied and often beautiful forms, those of sponges and "sea cucumbers" (Cucumariidæ and Synaptidæ) being especially striking in this latter respect, and are built up in all instances by the agency of scleroblasts—small nucleated protoplasmic masses which deposit the lime. The causes underlying the production of the curious forms which these spicules assume (triradiates, perforated plates, wheels and anchors, &c.) are not by any means yet understood, but are probably several in number, some being purely mechanical in nature, others, perhaps, being those which give rise to crystals.—Cellular constituents peculiar to cancerous and reproductive tissues: Prof. J. B. Farmer, F.R.S., Mr. J. E. S. Moore, and Mr. C. E. Walker. In the cells of malignant tumours, structures known as "Plimmer's bodies" are present in most cases. These structures have been regarded as parasitic organisms or as specific cellular peculiarities confined to such malignant tissues. They have recently been identified as also being present in normal reproductive tissues. They form a definite organ of the cell during its conversion to a spermatozoon, and they also can be identified in the two preceding divisions. They are absent from other cells of the body.—The simplest kind of protoplasm: Dr. Charlton Bastian, F.R.S. One drop of a fluid swarming with common bacteria had been introduced into one ounce of distilled water containing ten grains of neutral ammonic tartrate in solution. The bacteria grow freely in this fluid, and as the constitution of the ammonia salt is $2NH_4O, C_8H_4O_{10}+2HO$, they must fashion their protoplasm in some way from C, H, O, and N only, though sulphur and phosphorus, one or both, are commonly regarded as necessary constituents of living matter.

The parasite of "kala azar": Brevet Lieut.-Colonel W. B. Leishman. This protozoal organism is found in the spleen and other organs in cases of "kala azar," an extremely fatal disease occurring in epidemic form in Assam, and also, in endemic form, in other parts of India and the tropics. Nothing is yet known as to the mode of infection or as to the life of the parasite outside its human host. In artificial cultures it develops into a flagellated organism closely resembling a trypanosome. Specimens and sketches were shown of the parasites as they occur in the tissues, and of the flagellated forms into which they develop in artificial cultures.—The isolation of *B. typhosus* from water by means of alum precipitation: Mr. H. S. Willson. Alum is added to the infected water in the proportion of 0·5 gram to the litre. When the precipitate of aluminium hydrate has fully formed, the water is centrifugalised and the sediment containing most of the bacteria present in the water is spread on plates of suitable media, and incubated at 42° C. The precipitate, which is known to be destructive to many water and sewage organisms, has no germicidal action on *B. typhosus*.

(1) Stone adze heads in various stages of manufacture, and chips from the neighbourhood of Suloga, Woodlark Island, British New Guinea; (2) photographs of straight-haired individuals from Nara district central division, British New Guinea; (3) wood carvings and drawings, principally from Massim district, British New Guinea: Mr. C. G. Seligmann. Specimens of cross-bred maize illustrating inheritance in accordance with Mendel's law: Mr. R. H. Lock.—Living representatives of the Plymouth marine fauna: Marine Biological Association. Material obtained with the dredge from certain typical grounds in the neighbourhood of Plymouth was shown, together with representatives of the animals living on each ground.—Photographs illustrating young cuckoo in the act of ejecting egg and young bird from nest of foster-parent: Mr. W. Percival Westell.

A new problem on superposition: Mr. H. E. Dudeney. This was a demonstration that an equilateral triangle can be cut into four pieces that may be re-assembled to form a square, with some examples of a general method for transforming all rectilinear triangles into squares by dissection.

Oil painting, a Friday evening lecture at the Royal Institution: Mr. H. J. Brooks.

ATMOSPHERIC ELECTRICITY OBSERVED FROM BALLOONS.

IT is now some years since attempts were first made to investigate the electrical conditions of the upper atmosphere by aid of manned balloons; but it is only within the last three years that the difficulties of the observations and the proper methods to be used have been anything like understood.

Measurements of the normal potential gradient were first attempted. The early observers worked very much in the dark, Linke being the first, in 1901, to investigate the errors due to the mere presence of the balloon itself. He found that for the influence of an uncharged balloon to be small enough to be neglected, the upper of the two collectors used must be at least 10 metres below the basket.

Linke also investigated the efficiency of different forms of collectors. The original form of collector used in balloon work was a modification of Kelvin's drop collector. A wire was lowered from an insulated vessel out of which water flowed and ran down the wire; the drops forming on the end of the wire and then falling off brought the whole wire to the potential of the air at its end. There are many objections to this form of collector; it is very slow in action, uses a large quantity of water, and will not work when the temperature falls below freezing. Flame collectors are obviously out of the question for balloon work on account of their danger, and, much to the regret of the experimenters, radium did not come up to expectation. The difficulty with radium collectors is that the radium ionises a large volume of air, which, on account of the absence of relative motion between the balloon and the surrounding air, travels along with the balloon and completely alters the electrical conditions of the atmosphere in its neighbourhood. By a simple device Linke has finally overcome all difficulties connected with the collectors. A vessel containing spirits is insulated on a shelf fastened to the outside of the basket. From this vessel hangs a long thin lead or other flexible pipe. At the lower end of the pipe is a nozzle which forms the collector proper. As stated above, the collector must be 10 metres below the balloon; thus there is at least a 10-metre head of liquid acting at the nozzle. The pressure due to this causes a very fine jet to escape from a pinhole in the nozzle. As the jet breaks up into exceedingly fine drops, a very rapid collector action takes place. Collectors of this form have acted splendidly, and their use makes it possible to measure the potential gradient with accuracy and ease.

The rate of dissipation of electricity from a charged body, and the degree of ionisation of the air, have also been made subjects for investigation in the upper atmosphere. Ebert and Linke have devoted several ascents to measurements of the dissipation, and Ebert designed the first instrument to measure the natural ionisation of the air; but the ionisation has been most carefully investigated by Gerdien, who improved Ebert's instrument so that it measures not only the ionisation, but the conductivity of the air also.

It was when making these latter investigations that a number of difficulties connected with the casting of ballast were first observed. Ebert found that the pouring of sand from the ballast bags so highly charged the balloon with friction electricity that electrical observations became impossible. Gerdien found that after sand had been cast the balloon remained for some minutes in an atmosphere filled with fine sand dust, which greatly affected the measurements of the ionisation. Linke also found that on account of the sudden upward acceleration given to the balloon after sand had been cast the position of the electroscope leaves changed without any change of voltage. Gerdien was the first to overcome these difficulties. Besides sand, he took two large watertight sacks filled

with water. By having pipes and taps fitted to the sacks water could be discharged as desired. Sand still remained the ordinary ballast; but when electrical measurements were being made water only was used. In order to prevent the water freezing in the cold upper atmosphere, Gerdien filled the sacks with boiling water, which, experience proved, kept sufficiently warm to prevent freezing before it was all used. This method was found to be entirely satisfactory, for it not only got over all difficulties connected with the sand, but by regulating the flow of the water much greater control could be exercised over the balloon than had before been possible with sand.

These and other difficulties have been so recently recognised and overcome that trustworthy results have as yet hardly been obtained, but the observations appear to justify the following conclusions:—

The normal potential gradient remains positive to the highest point yet investigated (5900 metres by Gerdien), but decreases in magnitude as the height increases. This points to the lower regions of the atmosphere containing a positive charge equal to the negative charge on the earth's surface, so that the globe as a whole is not charged.

The number of ions in a cubic metre of air is the same at all heights.

Electricity is dissipated more rapidly from a charged body the higher it is in the atmosphere, this being, no doubt, due to the greater ease with which ions move in rarified air.

These results require further verification before they can be accepted as final, and it is to be hoped that facilities will be forthcoming for the investigations to be followed up in this country. It is a strange fact that no Englishman has yet devoted himself to a study which combines science and sport in such an attractive manner.

GEORGE C. SIMPSON.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The syndicate the proposals of which with regard to the previous examinations were thrown out by the Senate last term, was elected to consider the studies and examinations of the University, and, although it has so far considered but one examination, a determined attempt is being made to bring its deliberations to a close. The period for which the syndicate was appointed lapses at the end of this term, and the grace which authorises its re-appointment will to-day be "non-placetted" in the Senate. A short time ago four members were added to the syndicate. Their nomination was not objected to, though the action of the council in appointing them was termed inexpedient. It seems a strange piece of courtesy to acquiesce in the appointment of men like the master of Gonville and Caius, Mr. S. H. Butcher, late professor of Greek in Edinburgh, Dr. Adam, and Mr. Hardy to a syndicate which the opponents of change intended, so far as lay within their power, to render moribund.

The natural sciences tripos continues to increase. There are 149 candidates entered for part i. and 30 candidates for part ii., both of which began this week. In the first part of the mathematical tripos there are 57, and in the first part of the classical tripos there are 102 candidates, in the second part 12. The entrances for the mechanical sciences tripos, part i., are 45.

The Board of Agricultural Studies reports a continuous increase both in the number of students attending the agricultural courses and in the number presenting themselves for the examinations. The number of students is now close upon fifty, and shows an increase of seven within the last twelvemonth.

The honorary degree of M.A. will to-day be conferred on Mr. Robert Stephenson, late chairman of the Cambridgeshire County Council, in recognition of his services to education, and especially to the promotion of agricultural education in the university.

The Rede lecture will be delivered on Saturday, June 10, at 11.30 a.m., by Sir Francis Younghusband, K.C.I.E. His subject is "Our True Relationship with India."

The council of the Senate has promulgated a grace proposing that a syndicate be appointed to consider the desirability of establishing in the university a diploma in forestry, and to draw up, if it thinks fit, a scheme of instruction and examination in forestry; that it be empowered to consult with any persons or bodies; and that it report to the Senate before the end of the Lent term, 1906.

The next combined examination for sixty-two entrance scholarships and various exhibitions at Pembroke, Gonville and Caius, King's, Jesus, Christ's, St. John's and Emmanuel Colleges will be held on Tuesday, December 5, 1905, and following days, commencing at 9 a.m. on Tuesday, December 5. Mathematics, classics, and natural sciences will be the subjects of examination at all the above-mentioned colleges, and certain colleges examine in history, modern languages, and Hebrew.

OXFORD.—Dr. Henry Wilde, F.R.S., has presented 100*l.* to the Hope Department of Zoology for the purchase and preparation of specimens illustrating mimicry and protective resemblance.

The Romanes lecture for 1905 will be delivered by Prof. Ray Lankester, F.R.S., in the Sheldonian Theatre on Wednesday, June 14, at 2.30. The subject of the lecture will be "Man and Nature."

Mr. R. de J. Fleming Struthers has been elected to a senior scholarship in chemistry at Exeter College.

The Junior Scientific Club will hold a conversazione at the Museum on Tuesday, May 30.

MR. E. P. CULVERWELL has been elected to the professorship of education founded by the Board of Trinity College, Dublin, for a period of five years.

A REUTER telegram from Toronto reports that the Ontario Government has announced a provisional grant of 100,000*l.* to the University of Toronto toward the proposed new buildings which, it is estimated, will cost 320,000*l.*

IT has been announced, *Science* states, that the trustees of Columbia University have received 100,000*l.* from an anonymous donor for the construction of a new college hall; and that the Legislature of Minnesota has made direct appropriations for the University of Minnesota for the next two years amounting to 142,000*l.*, besides 12,000*l.* derived from the insurance on the old main building, destroyed by fire last September.

AN International Exhibition of Pedagogy, under the patronage of H.M. the King of Spain and of H.M. Queen Maria Christina, will be held in Barcelona from May to October. Particulars as to the scope of the exhibition and the conditions attaching to exhibits are given in the official programme, a limited number of copies of which can be obtained on application to the Director of Special Inquiries and Reports, Board of Education Library, St. Stephen's House, Cannon Row, Whitehall, London, S.W.

PRESIDING at the annual meeting of the British and Foreign School Society, Mr. A. H. D. Acland moved the adoption of the report on the year's work of the association. During the course of his speech, he remarked that in many schools too much is done for the brain and too little for the body. If hygiene, instead of being merely a special subject, were made part of the teacher's general outfit, much would be done for the health of the nation. Mr. Acland said he hopes also that by degrees the pest of examinations will be modified and got rid of—a matter in which the old universities are among the greatest sinners. Whoever could wipe out two-thirds of the examinations would be one of the greatest benefactors of the human species.

THE question of the concentration of the teaching of the preliminary and intermediate subjects of the medical curriculum in London at a few centres has long occupied the attention of those interested in medical education, as it has been felt that this step must result in greater efficiency in teaching, as well as economy in expenditure. The Westminster Hospital Medical School has been the first to take definite action in the matter, and has just completed negotiations with King's College by which arrangements have been made for the teaching of physics, chemistry, biology, anatomy, physiology, and materia medica (that is to say, the subjects of the preliminary and intermediate examinations) to Westminster students

of King's College. Students will enter Westminster Hospital Medical School as in the past, and will remain Westminster men; they will not become matriculated students of King's College, but they will be taught the earlier subjects of study at that institution. The scheme will come into effect at the commencement of next winter session in October. At the same time, the teaching of the subjects of the final examination is being completely re-organised. It is believed that this commencement of a probably more general concentration of the teaching of the preliminary and intermediate subjects of the curriculum cannot but promote the best interests of medical education in London.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—"On some Continuous Observations of the Rate of Dissipation of Electric Charges in the Open Air." By Dr. C. Coleridge **Farr**. Communicated by Dr. C. Chree, F.R.S.

During part of 1902 and 1903 the author resolved to take as many observations of the rates of dissipation of electric charges as possible, and to continue them over the whole day, and, when opportunity offered, over longer periods.

The observations were made on the Canterbury Plains of New Zealand, about 20 feet above sea-level, and five miles due west from the sea coast. The apparatus used was Elster and Geitel's[1] *Zerstreuungsapparat*. Corresponding observations were made of the direction and intensity of the wind (Beaufort), the humidity, and the potential difference between a point about 10 feet above the ground and the earth. This was determined by a Kelvin portable electrometer and a water-dropper.

The dissipation apparatus was read by a telescope, and at night it was illuminated by a bull's-eye lantern, but only during the actual time of reading.

The conductivity of the air is very irregular, but on an average negative electricity is dispersed more rapidly than positive.

$$\text{Taking } q = \frac{\text{conductivity of air for } -\text{ve electricity}}{\text{conductivity of air for } +\text{ve electricity}},$$

six ordinary days, embracing several hundreds of observations, gave an average of $q = 1.16$.

Yet on several occasions for some hours together during these six days, positive electricity was dissipated the more rapidly. The examples considered apparently indicate that a low value for q is, as might be expected, accompanied with a reversal of sign of the atmospheric charge. On one occasion, however, the potential became -185 volts with q about unity.

Again, considering the six days only, as more typical of ordinary conditions than two others to be referred to, there is distinct evidence of a double maximum and minimum value for the conductivity throughout the day for charges of both signs.

Of two other days, viz. February 1 and 2 and December 15 and 16, the former exhibits no distinct maxima and minima, but a strong south-west gale was blowing; the latter day is incomplete.

Observations on February 1 and 2, and on March 1 and 2, during south-west gales gave a much higher value for the conductivity for both positive and negative charges than usual. Since the wind on these two days was in the same direction, there is only a slight amount of evidence that the excessive conductivity is due to the strength rather than to the direction of the wind.

Two days not yet mentioned, viz. February 18 and March 16, may now be referred to. On the first of these a strong gale from the north-west was blowing when the observations were begun. On the latter, at 6.30 a.m., it was calm; at 8 a.m. there was a light south-west wind, and at 9.30 it was blowing strongly from the north-west with a characteristic falling barometer. These "nor'westers" blow over a range of mountains reaching 7000 feet, and deposit their moisture on the western slopes, though the rain often extends to the eastern side. In Christchurch they are invariably dry and hot, being of the nature of "Foehn" winds, and have a depressing effect upon most people.

[1] Elster and Geitel, "Terrestrial Magnetism," vol. iv., p. 213 *et seq.*

Though the above days are the only two of the class upon which, so far, the author has taken dissipation observations, yet potential observations indicate that the winds are negatively charged relatively to the earth, which is contrary to the usual condition. On both days the dissipation curves show marked peculiarities. The earliest observation, at 11.15 a.m. on February 18, gave $q = 0.4$, with a negative potential difference between water-dropper and earth of -300 volts at 10.20 a.m., -150 volts at 11.40 a.m., and -50 volts at 12.45 p.m. Corresponding with this rise of potential there is also a marked rise in the value of q.

On March 16 the whole history is apparent: At 7.30 a.m. the wind was light south-west, $q = 1.3$, potential $+90$ volts. At 9.45 a.m., wind north-west, strong, $q = 0.7$, potential -250 volts. At 10.30 a.m., wind north-west, strong, $q = 1.1$, potential -100 volts approximately. The north-west wind seemed then to have thoroughly established itself. The values of q became less and less, the curves indicating the conductivity of the air for positive and negative charges diverging rapidly, that for positive reaching a high value, whilst the negative curve reached remarkably low values. Corresponding with the extremely low value for q the potential reached its greatest negative value, -1885 volts. After this q increased and the negative potential decreased, until at 4.30 p.m. $q = 0.94$, potential -30 volts.

March 30.—"On a New Type of Electric Furnace with a Re-determination of the Melting Point of Platinum." By Dr. J. A. **Harker**. Communicated by Dr. R. T. Glazebrook, F.R.S.

The first part of the paper deals with a description of a new type of electric furnace for the attainment in absence of noxious gases of temperatures between 800° C. and 2200° C. The conductor conveying the electric current is a tube of solid electrolytes similar in composition to the filament of a Nernst lamp. An essential feature is that, for many purposes, the usefulness and life of a furnace constructed in this way may be much increased by adopting a "cascade" system of heating. That is, the energy supplied may be divided, so that only sufficient is put through the tubular conductor itself to raise its temperature, say 1000° C. above its surrounding, the surrounding itself being maintained at 1000° C., thus enabling a temperature of 2000° C. to be attained in the tube without straining it unduly.

The regulation of temperature in small furnaces of this type is so perfectly under control that very well defined melting points may be taken with very small quantities of substance.

The second half of the paper deals with a re-determination of the melting point of platinum by the thermo-electric method in these furnaces, the highest value found being 1713° C., the lowest 1702° C., and the mean result of the experiments 1710° C. ± 5° C.

May 11.—"The Effect of Plant Growth and of Manures upon the Soil: the Retention of Bases by the Soil." By A. D. **Hall** and N. H. J. **Miller**. Communicated by Prof. H. E. Armstrong, F.R.S.

The investigation deals first with the variations in the amount of calcium carbonate—the only basic substance usually available in soils—in the experimental plots at Rothamsted. In four of the fields which have been unmanured during a long period, the loss of calcium carbonate amounts to about 1000 lb. per acre per annum. This rate of loss is much increased on some of the manured plots; the use of ammonium sulphate and chloride, as sources of nitrogen, causes an increased loss of calcium carbonate which is equivalent to the amount required to neutralise the acid of the salts applied.

When sodium nitrate is used as a manure the rate of removal of calcium carbonate is lower than on the unmanured plots. Farmyard manure has also a similar conserving effect on the calcium carbonate in the soil. Evidence is also brought forward showing that many soils which are initially very poor in calcium carbonate retain their fertility unimpaired for many years, and even show

no decline in the small amount of base they contain, although nitrification is always going on and requires a supply of base from the soil. The authors show, from experiments with water cultures and from a consideration of the analyses of field crops, that the growing plant withdraws more acid than base from the neutral salts dissolved in the soil water, leaving behind a basic residue in the form of bicarbonate. Calcium oxalate and other organic salts in plant residues are converted by bacterial action in the soil into calcium carbonate. These two agencies restore bases to the soil in quantities approximately equivalent to their removal by nitrification, and so maintain a neutral reaction in the soil.

Zoological Society, May 2.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—Specimens of domestic chicks to illustrate peculiarities in the hereditary transmission of white plumage: W. **Bateson.**—On *Leucosolenia contorta* (Bowerbank), *Ascandra contorta* (Haeckel), and *Ascetta spinosa* (Lendenfeld): Prof. E. A. **Minchin.** The author pointed out that the nomenclature of the Calcarea Homocœla was in a more tangled state than that of any other group of the animal kingdom, with, perhaps, the exception of the malarial parasites. Dr. Bowerbank, who founded the species, gave a diagnosis that would fit any Ascon, and his type specimens were jumbles of three or four species; consequently Prof. Minchin declared his name to be of no systematic value whatever. To Haeckel's name *Ascandra contorta,* Prof. Minchin referred a sponge extremely abundant on the Mediterranean coasts of France. Prof. Minchin preferred to name *Ascandra contorta*, H., as *Clathrina contorta*. He believed that the *Ascetta spinosa* was only an age variation of *Clathrina contorta*, not yet possessing monaxon spicules.—Anatomy of the ferret-badger (*Helictis personata*), based on a dissection of a specimen that had recently died in the society's gardens: F. E. **Beddard.**—The osteology of the Eurylæmidæ, and the question of the systematic position of this group: W. P. **Pycraft.** While agreeing with the general consensus of opinion as to the primitive character of these birds, the author held that the isolated position which they were supposed to occupy with regard to the remaining Passeres was by no means justified by facts. The pterylography, osteology, and myology of the Eurylæmidæ all tended to show that the nearest allies of these birds were the Cotingidæ. Although undoubtedly primitive, the group, Mr. Pycraft pointed out, presented a number of specialised characters, which were especially marked in the skull and muscles of the wing.

Entomological Society, May 3.—Mr. F. Merrifield, president, in the chair.—A series of *Xenarthra cervicornis,* Baly, from Ceylon, illustrating the curious structure of the antennæ of the ♂: M. **Jacoby.**—Specimens of *Tephrosia consonaria,* ab. *nigra,* and melanic examples of *Boarmia consortaria,* all from a wood in west Kent: G. T. **Porritt.** These forms were exactly on the same lines as the melanism in west Yorkshire, and it is curious they should occur in such widely separate localities. The two genera, however, are evidently prone to melanism, as Mr. Porritt had now seen black, or almost black, specimens of all the British species except *Tephrosia punctulata.*—(1) Two specimens of the very rare Staphylinid, *Medon castaneus,* Grav., taken in the Oxford district during the last week of April; (2) several examples of both sexes of the giant flea *Hystrichopsylla talpae,* Curtis, from field-mouse nests in the same district; (3) the type-specimen of the Bostrichid beetle *Dinoderus ocellaris,* Steph. (taken by the late Prof. Westwood at "Little Chelsea" previous to 1830), from the Hope collection at Oxford: Commander J. J. **Walker.**—Heliotropism in Pararge and Pyrameis: Dr. G. B. **Longstaff.**—The structure and life-history of *Psychoda sexpunctata,* Curtis: J. A. **Dell.**—The three-colour process as applied to insect photography: Dr. D. H. **Hutchinson.**

Mathematical Society, May 11.—Prof. Forsyth, president, in the chair.—The following papers were communicated:—The intersection of two conic sections: J. A. H. **Johnston.** The object of the paper is to determine the number (0, 2, or 4) of the real intersections of two real conics by means of formulæ involving the invariants, or other concomitants of the system. The discrimination depends upon the signs of the coefficients of a certain cubic equation, one root of which can be interpreted, when all the intersections are real, as the area of the quadrilateral formed by them. It is shown that one of the conditions of reality obtained by previous writers admits of very great simplification.—On a system of conics yielding operators which annihilate a cubic, and its bearing on the reduction of the cubic to a sum of four cubes: H. G. **Dawson.**—Informal communications were made as follows:—High Pellian factorisations: Lieut.-Colonel A. **Cunningham.** A method was explained for constructing very large factorisable numbers of the form y^2+1 (with complete resolution into prime factors) from the Pellian equation $y^2-Dx^2=-1$. Examples were given, among them being a number of 78 digits, viz. $(2^{128}+3\cdot2^{42})^2+1$; this was shown to be expressible as $(2^{84}+1)(2^{86}+1)^2$, for which the resolution of the factors $2^{84}+1$ and $2^{86}+1$ had been obtained by Lucas.—The stability of a loaded column: Prof. A. E. H. **Love.** When the column can be treated as a "thin" rod, and the contraction of the longitudinal filaments is taken into account, the critical length is slightly greater than that obtained by the ordinary method, due to Euler, in which this contraction is neglected. The correction of the critical length is found to be $\frac{1}{4}\pi k$, where k is the radius of gyration of the cross-section of the column about an axis through its centroid at right angles to the plane of bending.

PARIS.

Academy of Sciences, May 15.—M. Troost in the chair.—The president announced the death of M. Potier, member of the section of physics.—The permeability of glass vessels: M. **Berthelot** (see p. 88).—The propagation of musical sounds in a tube of 3 metres diameter: J. **Violle** and Th. **Vautier.** Notes of low pitch carry much better than those of high pitch, the distance at which the sound ceases to be clearly a musical note being inversely as the square root of the number of vibrations, this result being in accord with the theoretical investigations of Lord Rayleigh. From a large number of observations the conclusion is drawn that the velocity of sounds of different pitch is the same to an accuracy of 1 part in 1000.—On the menthones and menthols obtained by the reduction of pulegone by the catalytic action of reduced nickel: A. **Haller** and C. **Martine.** Pulegomenthone was obtained when the nickel was maintained at 140° to 160° C.; its physical and chemical properties are given, and there is reason to suppose that the ketone obtained is a mixture of menthones, and further work is being carried out in this direction. By slightly modifying the conditions of the reduction an additional pair of hydrogen atoms is taken up, giving pulegomenthols, two of which, in addition to ordinary menthol, were isolated from the product of the reduction.—On the constitution, saccharification, and retrogradation of potato starch: L. **Maquenne** and Eug. **Roux.** Natural starch is regarded by the authors as a mixture of two substances, distinguished by the names amylocellulose and amylopectine, possessing different reactions towards iodine and malt extract.—The basic magnesium carbonates from the Santorin eruption of 1866: A. **Lacroix.** The structure of this mineral, the quantities of which were too small for quantitative analysis, agrees with that of the basic carbonate $4MgCO_3.Mg(OH)_2.4H_2O$. As this appears to be a new species, the name of giorgiosite is proposed for it.—On the lifting power of a motor-driven helix: **Prince of Monaco.**—M. Louis Henry was elected a correspondant for the section of chemistry in the place of Prof. Williamson.—On a photographic meridian telescope for determining right ascension: Jean **Mascart** and W. **Ebert.**—On the forces giving rise to conical trajectories: Cyparissos **Stéphanos.**—On the electrostatic rigidity of gases at high pressures: Ch. Eug. **Guye** and H. **Guye.** Measurements were made of the explosive potential in gases at varying pressures. The gases studied were nitrogen, air, oxygen, hydrogen, and carbon dioxide, the pressures varying from 2 to 65 metres of mercury. Up to 10 atmospheres, the explosive potential is a linear function of the pressure, but for higher pressures the ratio of explosive potential to pressure diminishes. The results were unaffected by the presence of a radium salt.—On the effects of Foucault currents and the hysteresis of iron on oscillatory sparks: G. A. **Hemsalech.** By means of a

photographic method it has been found that the effect of Foucault currents is to augment the frequency of the oscillations per second without influencing the number of oscillations in each discharge. Hysteresis destroys the oscillations and diminishes, more or less, the frequency.—A study of the radiographic power of an X-ray tube: S. **Turchini.** The radiographic effects, as measured by the action on a photographic plate, are found to follow the same laws as the radioscopic effects, and there is reason to suppose that the radiotherapeutic effects will follow similar laws as regards the relation between efficiency and the length of the equivalent spark.—On the conductivity of the gases from flames: Eugène **Bloch.** The ions contained in the gases given off from a flame, at the end of a time sufficiently long take a mobility of the order of 0·01 mm., and hence should be classed as large ions.—On the ionisation and coefficient of magnetisation of aqueous solutions: Georges **Meslin.**—The properties of pyrrhotine in the magnetic plane: Pierre **Weiss.**—On the causes of varieties of halation in photographic plates: A. **Guébhard.**—The triboluminescence of metallic compounds: D. **Gernez.** The luminous effect observed when certain crystals are broken is not, as has been supposed, essentially a property of organic compounds, and a list of seventy-four inorganic compounds is given in which this effect has been observed.—The properties of some anhydrous chlorides of metals of the rare earths: Camille **Matignon.** Details are given of the crystalline form, colour, density, melting points, heats of solution and formation of the chlorides of lanthanum, praseodymium, neodymium, and samarium.—On a reaction of rhodium: Piñerûa **Alvarez.** Chlorine, acting on an alkaline solution of a rhodium salt, gives a characteristic blue colour, due to the formation of sodium perrhodate.—The action of the metal ammoniums on alcohols: a general method for the preparation of the alcoholates: E. **Chablay.** The alkali ammoniums, acting upon a solution of the anhydrous alcohol in ammonia, give a quantitative yield of the alcoholate.—Propionylcarbinol and its derivatives: André **Kling.**—Contribution to the study of the derivatives of benzodihydrofurfurane: A. **Guyot** and J. **Catel.**—On methæmoglobin: M. **Piettre** and A. **Vila.**—Researches on the mode of action of philocatalase: F. **Batelli** and Mlle. L. **Stern.** The name philocatalase is given to a ferment which is present in many animal tissues, although without direct action on catalase it possesses the property of protecting the catalase against the destructive action of anticatalase. The present paper deals with the mechanism of this reaction.—Researches on the comparative power of adhesion of different copper solutions employed as a remedy against mildew: E. **Chuard** and F. **Porchet.**—On a bacterial decay of cabbage: Georges **Delacroix.**—The classification and nomenclature of arable earths according to their mechanical constitution: H. **Lagatu.**—The termination of the motor nerves in the striated muscles of man: R. **Odier.**—On the problem of statical work: Ernest **Solvay.**—On the overlapping strata in the Piedmont zone: Maurice **Lugeon** and Émile **Argand.**—On an extraordinary halo: M. **Pernter.**

DIARY OF SOCIETIES.

THURSDAY, MAY 25.

ROYAL SOCIETY, at 4.30.—Croonian Lecture, "The Globulins": W. B. Hardy, F.R.S.

ROYAL INSTITUTION, at 5.—Electro-magnetic Waves: Prof. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Wireless Telegraphy Measurements: W. Duddell and J. E. Taylor.

FRIDAY, MAY 26.

ROYAL INSTITUTION, at 9.—The Development of Spectro-chemistry: Prof. J. W. Brühl.

PHYSICAL SOCIETY (at the National Physical Laboratory), at 3.30.—The Specific Heat of Iron at High Temperatures: Dr. Harker.—The Measurement of Small Inductances: Mr. Campbell.—Two New Optical Benches: Mr. Selby.

SATURDAY, MAY 27.

ROYAL INSTITUTION, at 3.—The Evolution of the Kingship in Early Society: Dr. J. G. Frazer.

THURSDAY, JUNE 1.

ROYAL INSTITUTION, at 5.—Electro-magnetic Waves: Prof J. A. Fleming, F.R.S.

INSTITUTION OF MINING ENGINEERS (in the Rooms of the Geological Society), at 11 A.M.—The Firing of Babcock Boilers with Coke-oven Gases: T. Y. Greener.—Compound Winding-engine at Lumpsey Mine: M. R. Kirby.—Note Supplementary to a Paper on the Electric Driving of Winding-gears: F. Hird.—Electric Winding-engines at the Exhibition of the North of France, Arras, Pas-de-Calais: Ed. Lozé.—The Education of Mining Engineers in the United States: Prof. Howard Eckfeldt.—An Outline of Mining Education in New Zealand: Prof. James Park.—Goaf-blasts in Mines in the Giridih Coal-field, Bengal, India: Thomas Adamson.

LINNEAN SOCIETY, at 8.

CHEMICAL SOCIETY, at 8.—(1) The Constituents of the Seeds of *Hydnocarpus Wightiana* and *Hydnocarpus Anthelmintica*. Isolation of a Homologue of Chaulmoogric Acid.—(2) The Constituents of the Seeds of *Gynocardia Odorata*: F. B. Power and M. Barrowcliff.—The Relation of Ammonium to the Alkali Metals. A Study of Ammonium Magnesium and Ammonium Zinc Sulphates and Selenates: A. E. H. Tutton.—Camphorylazoimide: M. O. Forster and H. E. Fierz.—Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds. Part III. Azo-derivatives of the Symmetrically Disubstituted Primary Metadiamines: G. T. Morgan and W. O. Wootton.—Diazo-derivatives of Mono-acylated Aromatic Para-diamines: G. T. Morgan and Miss F. M. G. Micklethwait.—The Significance of Optical Properties as Connoting Structure; Camphorquinone-hydrazones-oximes; a Contribution to the Chemistry of Nitrogen: H. E. Armstrong and W. Robertson.—Solubility as a Measure of the Change undergone by Isodynamic Hydrazones. (1) Camphorquinonephenylhydrazone. (2) Acetaldehydephenylhydrazone: W. Robertson.—The Design of Gas-regulators for Thermostats: T. M. Lowry.—The Constitution of Barbaloin. Part I.: H. A. D. Jowett and C. E. Potter.—Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds. Part IV. 5-Bromo-*as*(4)-Dimethyl-2:4-diamine-toluene: G. T. Morgan and A. Clayton.—The Action of Hypobromous Acid on Piperazine: F. D. Chattaway and W. H. Lewis.—The Action of Magnesium Methyl Iodide on Pinene Nitroso-chloride: W. A. Tilden and J. A. Stokes.—Racemisation Phenomena during the Hydrolysis of Optically Active Menthyl and Bromyl Esters by Alkali: A. McKenzie, and H. B. Thompson.

FRIDAY, JUNE 2.

INSTITUTION OF MINING ENGINEERS (in the Rooms of the Geological Society), at 10.30 A.M.—The Conveyor-system for filling at the Coal-face, as practised in Great Britain and America: W. C. Blackett and R. G. Ware.—Underground Fires at the Greta Colliery, New South Wales: J. Jeffries.—The Geology of Chunies Poort, Transvaal: A. R. Sawyer.—Underground Horses at an Indian Colliery: T. Adamson.—Description of the Eimbeck Duplex Base-line Bar: W. Eimbeck.

SATURDAY, JUNE 3.

ROYAL INSTITUTION, at 3.—Exploration in the Philippines: A. H Savage Landor.

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THURSDAY, JUNE 1, 1905.

PUBLIC HEALTH AND SEWAGE PURIFICATION.

Sanitary Law and Practice. A Handbook for Students. By W. Robertson, M.D. (Glas.), D.P.H., and Charles Porter, M.D., B.Sc. (Public Health), M.R.C.P. Edin. Pp. xiii+756. (London: Sanitary Publishing Co., Ltd., 1905.) Price 10*s.* 6*d.* net.

The Sewage Problem. A Review of the Evidence Collected by the Royal Commission on Sewage Disposal. By Arthur J. Martin, Assoc.M.Inst.C.E., M.R.San.I. Pp. xvi+363. (London: Sanitary Publishing Co., Ltd.) Price 8*s.* 6*d.* net.

Simple Methods of Testing Sewage Effluents. For Works Managers, Surveyors, &c. By George Thudicum, F.I.C. Pp. 60. (London: Sanitary Publishing Co., Ltd., n.d.) Price 2*s.* 6*d.* net.

THE official responsibility for the safeguarding of the public health rests mainly with the representatives of four professions, viz. the medical officer, with his colleague the sanitary inspector, the bacteriologist, the engineer, and the chemist. A study of the volumes under review has strengthened the belief that it is desirable that members of each profession, while working cordially together for a common end, should severally recognise their respective limitations.

The text-book on "Sanitary Law and Practice" by Drs. Robertson and Porter is written in sections, each section referring to some special branch of public health work. A considerable portion of each section is occupied by a digest of the legal enactments affecting the subject, this being followed by paragraphs dealing, by description and advice, with the practical duties of the health officer. The condensation of legal information, so far as can be estimated by references to special points coming under the experience of the reviewer, is done with judgment, and constitutes a feature of the book, of great value alike to the student and to the practitioner.

Many useful hints from the wide experience of the authors are to be found in the descriptive portions of the book. Their experience, however, is naturally not all-embracing, and it is not difficult to note where their information is derived from the statements of others.

The subject of destructors, although coming within the province of the engineer, is evidently one with which the authors are familiar. The descriptions are clearly written, and the essential points in construction, choice of site, and proper management well brought out.

In the section on food and drugs no attempt is made to instruct the medical officer in duties which properly belong to the public analyst. This is satisfactory in view of the attempt frequently made by small authorities to combine the offices of public analyst and medical officer. Even in such a comparatively simple matter as the analysis of a sample of water, which in the chapter on water supply (p. 433) is referred to as part of the medical officer's duties, unsuspected pitfalls may lurk. It is doubtful whether bacteriological examinations should ever be undertaken by any but a trained bacteriologist, at any rate where identification of a given species is required.

In the section on disinfection a questionable prominence is given to the use of sulphur. The authors themselves, in a later paragraph, deprecate the use of superheated steam as being "no better than a gas," and in view of the obvious disadvantages in the use of sulphur, which have given rise to serious complaint of destruction of fabrics and fittings, especially on board ship, it can hardly be compared with liquid disinfectants such as formalin. No reference is made to the use of hypochlorites, which in certain circumstances have been found to give excellent results.

A wise reserve is maintained on the vexed question of sewer ventilation, a qualified approval being given to upcast shafts. It is unfortunate that a similar reserve has not been exercised in the chapter on sewage purification. In a book intended for students it is unwise to select, even for description, any form of patented appliance which is not thoroughly established. The choice for special commendation of one particular patented apparatus, concerning the merits of which competent opinion can at least be said to be divided, is certainly to be deprecated. A clear exposition of general principles of sewage treatment would have been more valuable.

This leads to the consideration of the able condensation of the bulky volumes of evidence given before the Royal Commission on Sewage Disposal which is to be found in Mr. Martin's book on the "Sewage Problem." Mr. Martin has provided a book which will be eagerly sought after by members of sewage committees and others who are appalled at the mass of matter in the numerous blue-books published by the commission. He is to be congratulated upon the impartial way in which he has marshalled the evidence. Possibly because of this impartiality the impression left upon the reader is that in spite of the great amount of work that has been done on the subject, sewage purification is still rather an art than a science.

The Royal Commission has been criticised for the slowness of its methods. A more just criticism would be that it might have devoted more energy to questions affecting the theory of the processes in use. As it is, a mass of empirical and sometimes conflicting information has been accumulated, from which it is extremely difficult to extract underlying certainties. While fully realising that a large part of the sewage problem is concerned with purely practical questions of cost and local conditions, yet ultimately the economic solution must depend on a full knowledge of the changes taking place in the course of various methods of treatment; and these are as yet by no means perfectly understood. It is curious, *e.g.*, that no witness deals in any detail with the purely physical effects produced by contact with the filtering medium, although many observers, especially on the Continent, believe that these play a very large part in connection with the changes produced. It is by no means

certain even yet that anaërobic action is absolutely necessary at any stage of sewage purification. Many other equally important questions might be instanced on which knowledge is still extremely limited.

The outstanding result of the Royal Commission's labours which will most appeal to local authorities is the statement that adequate purification can be effected without land treatment, which, if recognised by the Local Government Board, will remove what is, in many cases, an impossible restriction. Their recommendation in regard to a central controlling and advisory authority, if resulting in the creation of a department similar to the Massachusetts Board of Health, may prevent great waste of public money. Such a board might exercise wise discretion as to the amount of purification necessary under given conditions. No central control, however, can be effective without efficient local management, and Mr. Thudicum's little book of simple methods of sewage analysis will be of great assistance to local engineers and intelligent works managers, and will help to lighten the work of the trained specialist, with whom the solution of difficulties ultimately rests. G. J. F.

AN AMERICAN CONTRIBUTION TO ARCHÆOLOGY.

University of Pennsylvania: Transactions of the Department of Archaeology: Free Museum of Science and Art. Vol. i. Parts i. and ii. Pp. 125. (Published by the Department of Archæology, 1904.)

THE most important article in this volume is the description of the American excavations at Gournià, in Crete, which have already been referred to in the pages of NATURE (September 15, 1904, p. 482). Miss Harriet A. Boyd, the leader of the expedition, gives a full and very interesting description of her work, illustrated by photographs which give the reader a very good idea of the beautiful scenery of the Gulf of Mirabello (well bestowed name!), on the shores of which she found her work. No more delightful spot for archæological exploration could be imagined. Leaving the rather arid and uninteresting Candiote shore, near which Knossos lies, dominated by the towering hill of Iuktas, on the top of which, so legend says, the god Zeus died and was buried, the traveller skirts the base of the Lasithiote mountain-mass and reaches the narrow isthmus of Hierápetra (the ancient Hierapytna). Before him rises a magnificent rocky wall of mountain, Thriphte by name, behind which is the peak called the Aphendi, or Lord of, Kavoúsi, the village which lies at its foot. This wall is rent by a mighty cleft, the chasm of Thriphte, which is one of the dominating features of the landscape. Along the base of the wall runs the high-road from Kavoúsi to Hierápetra across the isthmus, which is low-lying land, forming a complete break in the mountain-backbone of Crete. On the northern shore of the isthmus is a good beach, Pachyammos ("Deep-sand") by name; in the centre of it the traveller will see a large white house.

This was Miss Boyd's headquarters. All around are splendid mountains and "a coast-line as picturesque as any in Southern Europe," to quote her description, which is not exaggerated; she might have said "more picturesque than," with reason. Away to the left are the snowy heights of Lasíthi, the hills above the *skála* or landing-place of Ayios Nikólas, and distant rocky Spinalonga, still the home of a peculiar race of Mohammedan fishermen—corsairs not so very long ago. To the right is the little isle of Psyrà, swimming in the blue water. One would think that the excavators on the monotonous plains of Babylonia, whose doings are chronicled by Prof. Hilprecht in the last contribution to this volume,[1] would have given much sometimes to have been able to transport themselves for a brief space to such goodly surroundings!

Pachyammos lies a mile or so beyond, and east of, the scene of Miss Boyd's work, the low hill of Gournià, on which she has discovered the remains of a "Mycenæan," or more correctly "Minoan," town, a Bronze age settlement. It is a small Pompeii. One can walk up the sinuously curving little main street and look right and left into the ruined houses of the Bronze age "Minoans." There is even a sort of court-house or "palace," to give it the stereotyped appellation, with its right-angle of low steps quite on the model of the splendid right-angled stairways of Knossos and Phaistos, which Dr. Evans considers to have been theatres, the prototypes of the stepped Greek theatres of the classical period. This "palace" must have been the official centre of the town. Formerly, judging from classical analogies, one talked of a prince or "dynast" ruling from every one of these little palaces over his own little πόλις or city-state; but it will probably eventually be found that the ruler who lived in such a "palace" as that of Gournià was no more than a mere mayor or demarch, a member of an official bureaucracy analogous to that of ancient Egypt, dependent upon the metropolitan authorities at Knossos. It becomes more and more probable that Crete in Minoan days was a homogeneous and highly organised State like Egypt, not a mere congeries of a hundred warring villages, as in classical times.

The official centre was not the religious centre of the town. The cathedral of Gournià stood in the middle of the town, and was approached by a special street of its own.

"Not imposing as a piece of architecture," writes Miss Boyd (p. 41), "it is yet of unique importance as being the first 'Mycenæan' or 'Minoan' shrine discovered intact. The worshipper ascended three steps and through a doorway 1.50 m. wide entered an enclosure, about 3 m. square, surrounded by walls half a metre thick and 50 to 60 cm. high. The floor is of beaten earth."

The more noteworthy of its contents are

"a low earthen table, covered with a thin coating of plaster, which stands on three legs and possibly served as an altar, four cultus vases bearing symbols of Minoan worship, the disc, consecrated horns and double-headed axe of Zeus, a terra-cotta female idol entwined with a snake, two heads of the same type as

[1] Very curiously described as "A Lecture delivered before German Court and University Circles, by H. V. Hilprecht." In it Prof. Hilprecht tells us little or nothing about the excavations at Nippur that has not already appeared in his "Explorations in Bible Lands," and the photographs published are already well known to archæologists.

the idol, several small clay doves and serpents' heads, all of coarse terra-cotta, and a fragment of a pithos, on which a double-axe and disc are modelled in relief."

This important find has since been paralleled by Dr. Evans's discovery at Knossos of a similar shrine of the snake-goddess with fine glazed faïence figures, referred to in NATURE (vol. lxx. p. 482). But Miss Boyd was the first to discover the Minoan snake-goddess, of whose existence we had no inkling before the excavations at Gourniâ.

Another good find, of which Miss Boyd gives a fine facsimile plate, was the head of a bull in terra-cotta, a typically "Mycenæan" object, paralleled by the famous silver bull's head found by Schliemann at Mycenæ, and the Egyptian representations of golden *protomae* of bulls being brought as gifts to the court of Thothmes III. by the Mycenæan (or rather "Minoan") ambassadors from "Kefti" (Crete).

Miss Boyd's work has contributed results to Mycenæan lore which are of the highest importance, results upon which the officers of the American Exploration Society at Philadelphia, which dispatched her expedition, are to be heartily congratulated.

H. R. HALL.

ELECTRICAL THEORY AND PRACTICE.

Maxwell's Theory and Wireless Telegraphy. By H. Poincaré and F. K. Vreeland. Pp. xi+255. (London: A. Constable and Co., Ltd., 1904.) Price 10s. 6d. net.

Alternating Currents. Vol. i. By A. Russell. Pp. xii+407. (Cambridge: The University Press, 1904.) Price 12s. net.

What Do We Know Concerning Electricity? By Antonia Zimmern. Pp. vii+140. (London: Methuen and Co., n.d.) Price 1s. 6d. net.

Modern Electricity. By J. Henry and K. J. Hora. Pp. 355. (London: Hodder and Stoughton, 1905.) Price 5s. net.

Modern Electric Practice. Vol. v. Edited by M. Maclean, Pp. vi+287. (London: The Gresham Publishing Co., 1904.) Price 9s. net.

Electricity Control: A Treatise on Electric Switch-Gear Systems of Electric Transmission. By Leonard Andrews. Pp. xv+231. (London: Chas. Griffin and Co., Ltd., 1904.)

THE electrical engineer who wishes to keep pace with the development of his profession and desires to know something more than that which concerns only the particular branch in which he is engaged has a very hard task before him at the present day. He must, in the first instance, endeavour to keep an eye on the technical literature—the innumerable journals and proceedings, the monthly magazines, and the weekly papers—of at least four countries in three different languages. This is in itself a task of no mean difficulty, which is heightened rather than diminished by the various "abstracts" available. So rapid is the multiplication of journals and papers that one is tempted to think that the best advice to give a student would be to read nothing, as if he tries to read much he will waste more time over what is of no value to him than he will spend wisely on the one useful article in a thousand; one is tempted still more to wish that a rigorous technical censorship might be instituted which would allow nothing to find its way into print but that which was of permanent value to the world. In this way the amount of technical literature might be brought within reasonable limits by being reduced to, say, one-tenth of its present volume.

If this is true of the matter which is published in journals—which has, at least as a rule, the merit of originality—it is still more true of the matter which appears in the form of technical text-books. We imagine these books find a ready sale, else we cannot account for their publication; yet we do not know by whom they are read except the reviewers. This is exemplified by the six volumes before us, all of which have appeared within the last few months. With the exception of the first two, we would venture to say that it would have been just as well, and possibly even better, had they not been published. We do not mean thereby that they are bad books, though one of them we think, should not be left about where young electricians might see it; but they are not of merit enough to justify the expense of their publication or purchase.

Take, for example, Miss Zimmern's little volume; it is tastefully bound and clearly printed on good paper—there is something in its appearance strongly suggestive of a book of minor poetry. Add to this that it is pleasantly written and that there is nothing very seriously wrong with its statements, and its merits are summed up. On the other hand, we are confident that it would fail in its object of explaining the complex theories of modern electricity to the "general reader"; he might put down the book with the feeling that his knowledge had been increased, but it would be a mistaken notion. It requires genius of a very rare kind, such as was shown by Faraday in his "Chemical History of a Candle," or by Prof. Perry in his "Spinning Tops," to write a book of this kind; we intend no disparagement to the writer of this volume by saying that such genius is not shown in it.

Messrs. Henry and Hora's volume is of another stamp; in a preface which reads like a publisher's advertisement, the authors state that "the work will be found eminently practical, scientific, and accurate." We have found it quite the reverse, and feel sorry for the "apprentice" or "artisan" who "gains a complete knowledge of the fundamental principles of electricity" from its pages. This is a book which no self-respecting electrical censor, however lenient, would have allowed to appear in print.

The two last books on the list are not without merit or value, but it is at best of an ephemeral kind. Of "Modern Electric Practice" we have already expressed our views in writing of the previous volumes; the present one does not depart from the same high standard in production, and the three articles in section iv., dealing with boilers, engines, and auxiliary plant, are well written and well illustrated. The article on electrochemistry and electrometallurgy is less satisfactory. We must confess, however, that the inaccuracies noticed in previous volumes make us, unjustly perhaps, suspicious of the figures and data in the one be-

fore us. Mr. Andrews's book on "Electrical Control" is a descriptive treatise on switch-gear. It possesses the same disadvantages as "Modern Electric Practice"; one cannot learn electrical practice from a book; there is only one school—the practical school—in which one can learn the principles and details of construction of apparatus in one-tenth of the time and ten times as thoroughly as by means of written descriptions. Practical men are apt to complain that text-books are valueless, as they are written by theorists; we have read a great many text-books of late written by practical men, and have come to the conclusion that it is only the theorist who should write them. He can describe the underlying principles which persist when the fashion of their application alters; the practical man describes the methods of his practice which even as he writes become antiquated.

We have reserved to the last the two volumes which head our list. Messrs. Poincaré and Vreeland's book deserves a place in any electrical library on account of its remarkably simple and lucid explanation of Maxwell's theory and of the work of Hertz, Lodge, and others which led to the development of Hertzian telegraphy. This is from the pen of M. Poincaré, translated by Mr. Vreeland, and forms the first part of the book. The second part, written by Mr. Vreeland, deals with the problems presented by the practice of wireless telegraphy, and the writer, by wisely confining himself to principles rather than details, has succeeded in writing a worthy sequel to M. Poincaré's work.

Mr. Russell's book is the first volume of a mathematical treatise on alternating currents. Alternating current machinery is growing so steadily in importance, and the mathematical theory in connection with it is so complex, that there is plenty of room for a thorough and comprehensive work of this kind. The present volume deals with the general theorems, and the second will be devoted to the more specific theory of alternating current machines and the transmission of power.

MAURICE SOLOMON.

OUR BOOK SHELF.

Vegetationsbilder. Edited by Dr. G. Karsten and H. Schenck. Second series. Parts i.—viii. (Jena: Gustav Fischer, 1904.)

THE first series of the "Vegetationsbilder" met with well-merited success, and a second series has been appearing at intervals during the past year. Of the contributors to the first series, Drs. G. Karsten and E. Stahl have again supplied material, the former taking up a never-failing source of interest in the mangrove vegetation, whilst Dr. Stahl, in a double part, deals with the xerophytes and conifers of Mexico; amongst the latter the primeval Taxodium trees growing in the park of Chapultepec and the sombre cypresses on the road to the sacred mount of Amecameca bear the impress of historic antiquity. Another number, consisting of parts v. to vii., is devoted to the representation of mid-European forest trees, in accordance with an expressed desire for subjects taken from native sources. The photographs taken by Dr. L. Klein include typical specimens of conifers and beeches in the Schwarzwald and Switzerland, and others showing the changes wrought by browsing animals and devastating winds; many of them are excellent, notably a scene of wind-blown pines which have been entirely cleared of branches except to leeward, but similar subjects are accessible to most botanists, and for this reason they do not possess the interest attaching to photographs from less accessible countries. The names of several new contributors are announced, among them Mr. E. Ule, whose character sketches of epiphytes in the Amazon region of Peru appear in the first part of this series. Of the Cactaceæ, which are widely spread through South America, a number of genera include epiphytic species, and in this region Cereus is predominant. *Cereus megalanthus*, a species which might be called a climbing epiphyte, is shown perched on a Ficus tree. Another curious condition is that of a flourishing bromeliad, *Streptocalyx angustifolius*, where, according to the writer, the exuberance of vegetation is so directly traceable to ants that he compares the phenomenon with the fungus gardens described a few years ago by Dr. A. Moeller. The last part of the series contains photographs taken in the Italian colony of Eritraea by Dr. Schweinfurth. *Hyphaene thebaica*, the doum palm, familiar on account of its branching habit, the sycomore fig, and an arboreous Euphorbia are among the characteristic specimens chosen to illustrate different regions in the country.

Author and Printer. An Attempt to Codify the best Typographical Practices of the Present Day. By F. Howard Collins. Pp. xv+408. (London: Henry Frowde, 1905.) Price 5s. net.

THE want of uniformity of spelling, capitalisation, punctuation, and use of italic type causes continual trouble to all who are responsible for the editorial supervision of scientific literature in any form. Some authors are more German than the Germans in their use of capitals, while others underline their manuscripts as freely as ladies do their correspondence. It is frequently difficult to decide questions of orthography, and to reduce individual practice to the consistent style, which is desirable in the columns of a periodical, but is not always maintained. Mr. Collins has prepared his book to help in this end, as a standard guide for "Authors, Editors, Printers, Correctors of the Press, Compositors, and Typists."

The volume contains more than twenty thousand separate entries of words arranged alphabetically. Included among these are abbreviations, disputed spellings, foreign words and phrases, divisions of words, and various rules and explanations which should prove of service to authors and editors. The proofs of the work have been read by many writers and others who can give authoritative opinions as to what is correct or customary, so that the book does not contain merely Mr. Collins's decisions, but a consensus of opinion edited by him.

Highways and Byways in Derbyshire. By J. B. Firth. With illustrations by Nelly Erichsen. (London: Macmillan and Co., Ltd.) Price 6s.

WITH this book as a guide, a tourist could spend many pleasant weeks in Derbyshire, and he would learn that every part of the county has literary and historical associations of great interest. But while the human side is so well represented, little notice is taken of nature, except from the æsthetic point of view. "Of natural history and geology," says the author, "there is frankly nothing in this book, of science nothing, of sport nothing."

Notwithstanding this confession of what we may be permitted to describe as sins of omission, notes and descriptions of places in which scientific readers are particularly interested occur here and there. For instance, a short account is given of the stone circle of Arborlow, the Stonehenge of the Midlands. The monument consists of a circular enclosure in which are a number of blocks of limestone, all lying flat on

the ground in a rude circle, while at the centre are large blocks which probably formed the central dolmen. "There are two entrances to the enclosure, a northern and a southern, and on the east side of the latter is a large detached mound. Four hundred yards west of the main enclosure is a still larger mound, known as Gib Hill, connected with it by a low rampart of earth, now nearly worn away." Buxton and Matlock lead Mr. Firth to make some quotations from Erasmus Darwin's poetical references to them in his "Botanic Garden: Economy of Vegetation," and "Loves of the Plants." Dr. Darwin knew and loved the scenes he described, whatever opinion may be held as to his possession of the divine afflatus. There are a few other references to people and scenes of especial interest to the scientific world, but the book will not be valued for these so much as for its bright narrative of literary and historical centres of Derbyshire, and its fine illustrations.

The Tower of Pelée. New Studies of the Great Volcano of Martinique. By Prof. Angelo Heilprin. Pp. 62+xxii plates. (Philadelphia and London: Lippincott, 1904.)

PROF. HEILPRIN'S latest volume on Martinique is chiefly remarkable for the beautiful photographic plates with which it is illustrated; they give an excellent idea of the features of the great tower of solid lava which for nearly three years has been the centre of interest in the crater of Pelée. One of these plates, however (No. xi), seems to have been accidentally printed upside down. In the accompanying text there is an account of the author's fourth visit to the volcano in June, 1903, and a good deal of somewhat discursive matter regarding the lessons to be learnt from the recent eruptions. The number of points which are still unsettled concerning the mechanism of the explosions and the concomitant phenomena is very large, and the author shows a wise caution in dealing with some of them. He advances the opinion that the tower of Pelée is a volcanic core of ancient consolidation, and not an extrusion of solidified new lava, as the French observers believe. We cannot believe this is at all likely to obtain general acceptance. J. S. F.

Experimental Researches on the Flow of Steam Through Nozzles and Orifices. By A. Rateau. Translated by H. Boyd Brydon. Pp. iv+76. (London: Constable and Co., Ltd., 1905.) Price 4s. 6d. net.

THE laws of flow of steam are of much importance in the design of turbines. A clear sketch is given of the theory, and then an account of an excellent experimental research to determine the values of the constants. Amongst previous experiments, those of Napier are English, not American as the author states. The novelty in M. Rateau's method is the use of an ejector condenser for condensing the steam. The rise of temperature, which is easily measured, gives the quantity of steam condensed. The errors of the method, especially that due to entrained water, are carefully examined. Convergent nozzles and a thin plate orifice were used. The results are compared with those by Hirn on air, and close agreement is found. In a note, the complex phenomenon of the discharge of hot water just on the point of evaporating is examined.

The translation is clear. It is, however, a defect, for English readers, that the principal formulæ are left as given by the author in foreign units. The book is essentially one for practical use, and it would have added much to the convenience of engineers if other formulæ than the one on p. 6 had been given in English units.

Introductory Mathematics. By R. B. Morgan. Pp. vi+151. (London: Blackie and Son, Ltd., 1905.) Price 2s.

IN Mr. Morgan's "Introductory Mathematics" the view of the author is that as soon as a boy knows decimal and vulgar fractions he should begin a mixed course of elementary practical mathematics comprising algebra, geometry, and squared-paper work, developed as a whole in mutual dependence, leading up through the manipulation of formulæ to the solution of problems involving simultaneous simple equations and giving a knowledge of the fundamental facts of geometry with a training in practical applications such as the plotting of graphs and of figures to scale, and the finding of simple areas and volumes. This scheme, ignoring the old water-tight compartment system, is a good one. The chapters on algebra and geometry usually alternate, and the work progresses on natural and easy lines, with illustrations of every-day interest. The author might with advantage have carried the idea still further and have brought in computations from quantitative experimental work in the laboratory, involving the use of the balance and measuring flask, and perhaps an investigation of the action of forces at a point. There are some minor defects, such as an occasional lack of precision in a statement, bad perspective in several of the figures, the use of a graph to give a forecast of population fifty years hence, &c. But the treatment of the subject as a whole is very satisfactory; there is a good collection of exercises, and the book is well suited to its purpose.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Dynamical Theory of Gases and of Radiation.

LORD RAYLEIGH, in a letter which appears in NATURE of May 18, opens up the general question of the applicability of the theorem of equipartition to the energy of the ether. As the discussion has arisen out of my "Theory of Gases," may I, by way of personal explanation, say that although I was fully alive to the questions referred to in this letter when writing my book, yet it seemed to me better not to drag the whole subject of radiation into a book on gases, but to reserve it for subsequent discussion? Since then I have written two papers in which questions similar to those raised by Lord Rayleigh are discussed from different aspects, but as neither of these papers is yet in print, I ask for space for a short reply explaining how my contentions bear on the special points raised by Lord Rayleigh's letter.

May I, in the first place, suggest that the slowness with which energy is transferred to the quicker modes of ether-vibration is a matter of calculation, and not of speculation? If the average time of collision of two molecules in a gas is a great multiple N of the period of a vibration, whether of matter or of ether, then the average transfer of energy to the vibration per collision can be shown to contain a factor of the order of smallness of e^{-N}. The calculations will be found in §§ 236–244 of my book. It is on these that I base my position, not on a mere speculation that the rate of transfer *may* be slow. Lord Rayleigh's example of a stretched string, say a piano wire, will illustrate the physical principle involved. If a piano hammer is heavily felted, the impact is of long duration compared with the shortest periods of vibration, so that the quickest vibrations are left with very little energy after the impact, and the higher harmonics are not heard. If the felting is worn away, the impact is of shorter duration, the higher harmonics are sounded, and the tone of the wire is "metallic."

The factor e^{-N} is so small for most of the ether-vibrations as to be negligible. There is no sharp line of demarcation between those vibrations which acquire energy

very slowly and those for which the rate is appreciable; but as e^{-N} varies rapidly with N when N is large, there will be but few vibrations near the border, so that it seems legitimate, for purposes of a general discussion, to divide the vibrations into the two distinct classes, quick and slow, relatively to the scale of time provided by molecular collisions.

When the material bodies are solid, the physical principle is the same, the relatively slow motions of the atoms affecting the "quick" vibrations of the ether only by raising a sort of "equilibrium tide."

The number of "slow" vibrations of the ether in any finite enclosure is finite. These quickly receive the energy allotted to them by the theorem of equipartition. Thus they form the medium of transfer of radiant energy between two bodies at different temperatures. After a moderate time the slow vibrations have each, on the average, energy equal to that of two degrees of translational freedom of one molecule; the quick vibrations have no appreciable energy, while the intermediate vibrations possess some energy, but not their full share. It is easily seen that the number of slow vibrations is approximately proportional to the volume of the enclosure, so that roughly the energy of ether must be measured per unit volume in order to be independent of the size of the enclosure. For air under normal conditions, I find as the result of a brief calculation that this value is of the order of 5×10^{-9} times that of the matter. The law of distribution of this energy will be

$$\theta\lambda^{-4}d\lambda$$

until we arrive at values of λ which are so small as to be comparable with

$$\text{radius of molecule} \times \frac{\text{velocity of light}}{\text{velocity of molecule}}.$$

After these values of λ are passed, the formula must be modified by the introduction of a multiplying factor which falls off very rapidly as λ decreases, and which involves the time during which the gas has been shut up. It is easily found (*cf.* "The Dynamical Theory of Gases," § 247) that at 0° C. the spectrum of radiant energy is entirely in the infra-red; at 28,000° C. it certainly extends to the ultra-violet, and probably does so at lower temperatures.

Finally, Lord Rayleigh asks:—

"Does the postulated slowness of transformation really obtain? Red light falling upon the blackened face of a thermopile is absorbed, and the instrument rapidly indicates a rise of temperature. Vibrational energy is readily converted into translational energy. Why, then, does the thermopile itself not shine in the dark?"

Before trying to answer this, I wish to emphasise that my position does not require the *forces* of interaction between matter and ether to be small. Considering a gas for simplicity, the transfer of energy per collision to a vibration of frequency p is found to be proportional to the square of the modulus of an integral of the form (*cf.* "The Dynamical Theory of Gases," § 237)

$$\int f(t)e^{ipt}dt,$$

where $f(t)$ is a generalised force between matter and ether. The integral may be very small either through the smallness of $f(t)$ or the largeness of p. I rely entirely on the largeness of p, because calculation shows this to be adequate. The thermopile experiment gives evidence as to the magnitude of $f(t)$, but this does not alter the fact that the integral is small for large values of p.

This being so, I am afraid I do not very clearly understand why the thermopile should be expected to shine in the dark. If the red light is a plane monochromatic wave, its energy represents only two coordinates of the ether, and has to be shared between the great number of coordinates, six for each atom, which belong to the thermopile. If the red light comes from a large mass of red-hot matter inside the same enclosure as the thermopile, then the thermopile will soon be raised to the temperature of this mass, and *may* shine in the dark. If the hot mass consists of iron, say at 600° C., the atomic motions in the iron must be sufficiently rapid to excite the red vibrations in the ether. But if the face of the thermopile is of lampblack, the atomic motions in lampblack at 600° C. may not be of sufficient rapidity (mainly, so far as can be seen, on account of the lower elasticity of the material) to excite red vibrations except as a kind of "equilibrium tide," in which case the lampblack will not emit red radiation.

I cannot ask for further space in which to answer Lord Rayleigh's point as to the enclosure with a hole in it, but I have discussed a similar question in a paper which I hope will soon be published, in connection with Bartoli's proof of Stefan's law. I hope that this paper, and a second one which is at present in the hands of the printer, will explain my position more clearly than I have been able to in the short limits of a letter.

May 20. J. H. JEANS.

Fictitious Problems in Mathematics.

I HAVE to thank your reviewer for so readily supplying (NATURE, May 18, p. 56) the example to prove his contention—and which appears (to me) to disprove it.

The man who set that example did so in order to test (*inter alia*) whether the pupil knew that, for any friction to arise, both the surfaces must be rough; your reviewer originally wrote:—"What the average college don forgets is that roughness or smoothness are matters which concern *two surfaces* not *one body*." The italics are your reviewer's; and this is the statement which I called (and still call) in question.

It is no part of my book to uphold the verbiage in which the example is couched; by chance, in my former letter, I explained in anticipation the terms used in it. I do not see, however, why your reviewer applies the favourite word inaccurate to these terms. Perfect smoothness may not occur in nature; still, in considering the pendulum, I probably begin by assuming no friction on the axis of suspension, and, if I try afterwards to apply a correction for this friction, I probably make an assumption which is inaccurate. Friction = pressure × a constant is inaccurate, statically and dynamically.

C. B. CLARKE.

As I take it, the mathematician's "perfectly rough body" means a body which never by any chance slips on any other body with which it is placed in contact, similarly the "perfectly smooth body" is supposed never to offer any tangential resistance to any other body which it touches. The inconsistency of this nomenclature is evident when we imagine the two bodies placed in contact with each other, as in the case of the perfectly rough plank resting on the smooth horizontal plane. The subsequent course of events cannot at the same time be compatible with the assumed perfect roughness of the one body and the assumed perfect smoothness of the other. The coefficient of friction between two bodies depends essentially on the nature of the parts of the surfaces of both bodies which are in contact as well as on their lubrication, and neither body can be said to have a coefficient of friction apart from the other. It is equally incorrect to speak of perfect smoothness or perfect roughness as attributes of a single body. Moreover, this misleading language is quite unnecessary; it is very easy to frame questions in a way that is free from objection. For instance, "A man walks without slipping along a plank which can slip without friction on a horizontal table." Or again, "A sphere is placed in perfectly rough contact with the slanting face of a wedge whose base rests in perfectly smooth contact with a horizontal plane."

G. H. BRYAN.

A New Slide Rule.

IN the article which appeared on p. 45 of NATURE, May 11, describing the Jackson-Davis double slide rule, you notice one little fault in the rule sent for examination.

We desire to exonerate the designer of the instrument, Mr. C. S. Jackson, from responsibility for the very obvious fault to which you allude, viz. that the scale on the feather edge is divided into inches and sixteenths, and that the continuation scale which is read below the ordinary slide

is in millimetres. The rules can be supplied with the plain scales either in inches or millimetres, and in the specimen submitted to you the mix up is the result of accident, and not perversity.

JOHN DAVIS AND SON.

All Saints' Works, Derby, May 20.

THE LOWER VERTEBRATES.[1]

"EVERYTHING comes to him who waits"! Certainly the patience of many has been sorely tried by the long advent which has preceded the appearance of this last volume of the Cambridge Natural History. Students of the lower vertebrates will be naturally predisposed to accord it a favourable reception, inasmuch as its predecessors have presented such a high standard of excellence. If in some respects a closer acquaintance reveals some cause for complaint it will be admitted that, surveyed as a whole, both authors and editors alike are to be congratulated on having produced a work of sterling merit.

The groups dealt with in this volume are not only of the highest scientific interest and importance, but they present more than ordinary difficulties to be investigated, and these difficulties are materially increased when stern necessity compels the several contributors to condense their work within the smallest possible limits. Happily this task has fallen on the right shoulders, and all must admire the way in which it has been performed.

The first chapter of this book has been written by Dr. S. F. Harmer, and deals with the Hemichordata, a group which includes creatures of the existence of which the layman has never heard! Yet their importance in the scheme of evolution is of the highest, inasmuch as they bridge the gap for us between vertebrates and invertebrates.

The true nature of these worm-like and tubicolous animals has been determined only after the most laborious and painstaking research, in which Dr. Harmer, the author of this chapter has borne a very conspicuous share. Though the vertebrate affinities of the worm-like Balanoglossus were first hinted at by Kowalewsky in 1866, it was not until 1886 that this relationship was really demonstrated: a triumph achieved by Bateson. Forming at first a branch by itself of the vertebrate phylum, Balanoglossus has since lost something of its unique character by the discovery that certain other tubicolous forms—Rhabdopleura and Cephalodiscus—would have to be promoted to share this position, though to the ordinary observer nothing could be less like a vertebrate in appearance! This advance in our knowledge was made by the author of this chapter; and he has now still further extended the boundaries of this group so as to include Phoronis, an animal hitherto referred both to the Gephyrea and to the Polyzoa.

Although our knowledge of the Tunicates—those "common objects of the sea-shore," known as the "sea-squirts"—has been accumulating for something more than two thousand years, it was not until the middle of the eighteenth century that any real progress in the study of these creatures was made. And yet a century passed before the appearance of Kowalewsky's epoch-making work, which showed conclusively the astonishing fact that these shapeless jelly-bags were really kith and kin of the vertebrates—but degenerates!

No other group of animals is so all-embracing in the nature of the phenomena it displays. As the author remarks, "They demonstrate both stable and variable species, monophyletic and polyphyletic groups. They exhibit the phenomena of gemmation and of embryonic fission, of polymorphism, hibernation, alternation of generations, and change of function. They have long been known as a stock example of degeneration; but in fact they lend themselves admirably to the exposition of more than one 'chapter of Darwinism.'"

Prof. Herdman has made this group peculiarly his own, and the editors are to be congratulated in having secured him to write this chapter. Nowhere else will the student find so complete and altogether admirable a summary of this most difficult and puzzling group of animals.

In dealing with amphioxus Prof. Herdman has been hampered by lack of space. This seems evident, not from the absence of any essential facts in his account, but from the condensed fashion in which the facts are presented. To the majority of those who will use this book this is perhaps of no great moment, but others, we imagine, will fail to appreciate the full importance of some phases in the life history of this "weed in the vertebrate garden."

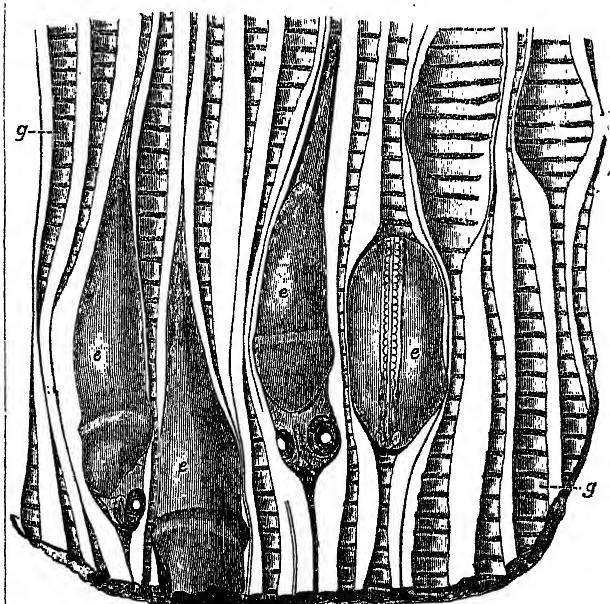


FIG. 1.—Embryos of *Rhodeus amarus* in the gill-cavities of Unio. *e*, Embryos; *g*, inter-lamellar cavities. From the "Cambridge Natural History."

The remarkable ciliated condition of the embryonic and early larval stages is, for example, all too lightly passed over. Attention is not called to the importance of the fact that in the free-swimming, ciliated larva we have a connecting link between vertebrates and invertebrates. His reference to the existence of cilia is of the briefest. He remarks simply, that "the embryonic stages being passed through during the night . . . the larva hatched in the early morning," and then, on the next page, continues, "The epiblast cells become ciliated all over the surface, so that the embryo rotates within the thin covering which still surrounds it." Passing on to describe the metamorphosis of the embryo he goes on to say that "When it has (developed) about five pairs of mesoblastic somites, it breaks out of its covering, and becomes a free swimming larva." Probably no living biologist knows more of amphioxus than Prof. Herdman. Thus, then, this lack of emphasis of a really important feature must be attributed to the fact that he had to

[1] "Hemichordata, Ascidians and Amphioxus, Fishes." By Drs. Harmer, Herdman, Bridge and G. S. Boulenger. The Cambridge Natural History, vol. vii. Pp. xvii+760. (London: Macmillan and Co., Ltd., 1904.) Price 17s. net.

compress his account unduly. As a matter of fact the whole history has been crowded into something less than eight and twenty pages, including illustrations!

This condensation is evident throughout each of the chapters so far noticed, and probably accounts for the absence of anything in the shape of an historical review of the evolution of our knowledge of these obscure groups. Surely this is to be regretted, inasmuch as this is a volume which will serve as the main source of information for many generations of students; and it would be well to place before them some idea of the laborious and patient work which has been spent by others in building up the knowledge which is theirs to-day. Such a review would serve a double purpose. It would keep alive the memory of those whose names are all too soon forgotten, and it would serve as an incentive to further work.

Probably this survey would not have been wanting, but for the fact that some two hundred and eighty of the seven hundred and twenty-seven pages which make up the book are devoted to the introduction on fishes! This is not as it should be; on this account serious

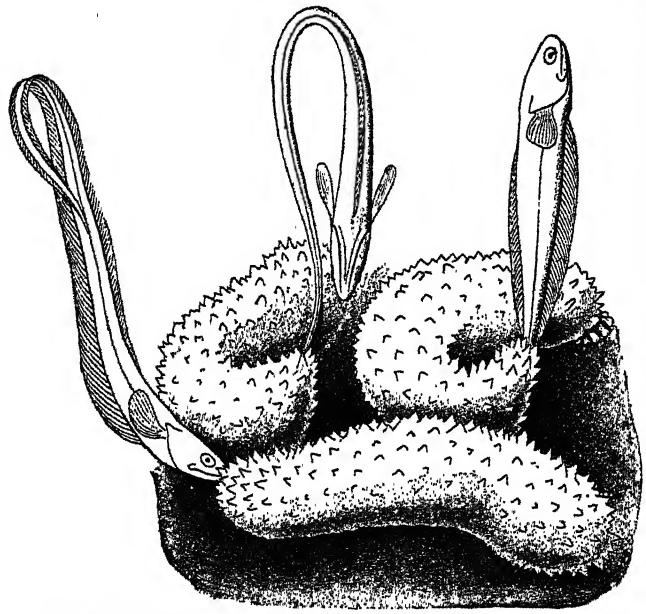


FIG. 2.—*Fierasfer acus* penetrating into Holothurians; two-fifths natural size. From the "Cambridge Natural History."

injury has been done both to the chapters which precede it and those which follow. Much of this introduction could have been dispensed with, inasmuch as matters of a purely physiological import are now included, and these are outside the scope of this volume. Lengthy as it is, it is yet incomplete. Morphological questions that should have found a place here are either ignored or dismissed in a few lines. If these had taken the room of the matter to which we object some justification might have been pleaded for the condensation of the exceedingly valuable chapters which we have just noticed. Yet, in spite of these drawbacks, this introduction will prove most valuable to those who use this volume as a text-book, and there is no doubt but that it will be widely read and highly valued in the various science schools throughout the kingdom.

It is a pity that more figures of larval fishes were not given in this introduction, designed to illustrate the remarkable transformations which some species especially undergo from the time of hatching to maturity.

In regard to the Cyclostomata it is curious that no mention is made of the extraordinary slime-secreting powers of the Myxinoids. True, he refers to "a row of mucous secreting sacs along each side of the body," but this scarcely does justice to the case; inasmuch as an instance is on record of a single individual which, placed in three or four cubic feet of water, converted the whole into a jelly-like mass, which could be lifted out with a stick! The specific name of *Myxine glutinosa* has reference to the old belief that the fish possessed the power of turning water into glue.

Prof. Bridge solves the difficulty as to the systematic position of Palæospondylus by placing them in a sort of limbo designated an "appendix to the fishes."

In this same appendix it is somewhat surprising to find not only the Ostracoderms, but the Arthrodira! As touching the former Prof. Bridge may claim that he errs, if erring he is, in good company, since so eminent an authority as Dr. Smith Woodward refuses to admit these "bones of contention" into the class Pisces. But we object to the hesitancy displayed by Prof. Bridge; he will neither call them fishes nor allow them to rank as a separate class (Agnatha), as Dr. Woodward has done. But surely there can be no question as to the class, at least, to which the Arthrodira belong? According to the most recent views they are to be regarded as Dipnoans.

In spite of these drawbacks Prof. Bridge's contribution to this volume is a valuable one. He has brought together a vast amount of information, much of which is the result of his own researches. Where he has had to draw upon the work of others he has for the most part selected of the best. Our chief complaint is that he is so meticulously exact.

The Teleostei, from a systematic point of view, are described by Mr. E. A. Boulenger, and he has brought to bear upon this most difficult task an unrivalled knowledge, tempered with rare skill and judgment. The classification which has been generally in use in this country for the last thirty years is now replaced by one which aims at being phylogenetic—the true basis of all systematic work. Although we believe Mr. Boulenger has improved on this arrangement in some minor details since passing the final proofs of his work some three years ago, it may be accepted as practically representing his views on this subject.

As he remarks, "Out of some 12,000 well-established species of fishes known to exist at the present day, about 11,500 belong to this order (Teleostei). The classification of such an array of forms is, of course, a matter of great difficulty, and gives scope for much difference of opinion among those who have attempted to grapple with the subject." The basis of this classification differs from that usually employed in other groups of vertebrates, inasmuch as it rests on osteological characters, in so far as families and higher groups are concerned.

The reader of this notice may imagine, from our ominous reference to dry bones, that Mr. Boulenger's contribution is of the nature of a dull and tiresome catalogue. We hasten to remark, therefore, that this element is effectually masked by the introduction of all the more important facts concerning the life-histories of the various species which have come within the author's province. These facts form most fascinating reading, and will appeal to a large number of people other than professed students of zoology. Do fishes sleep? is a question often asked. Although answered in the affirmative some eight and thirty years ago by Mobius, the fact has remained ever since practically buried in the German publication in which it appeared. Mr. Boulenger is apparently the first to give it circulation in a text-book. A species of Wrasse

confined in an aquarium, he points out, was observed by Mobius to seek a sleeping place at night, and to lay itself down to rest on one side. The psychologist and the student of evolution will find in these chapters of Mr. Boulenger a perfect mine of information. No more instructive lessons in adaptation can be gathered than from the descriptions and figures illustrating this part and certain sections of Prof. Bridge's work—as witness the text cuts given herewith.

ABORIGINAL INDIA.[1]

MR. BRADLEY-BIRT'S book dealing with the Santal Parganas merits the success achieved by his former volume on Chota Nagpore. This time, he lays his scene in the mountainous, forest-clad outlier of the Vindhyan range, which stands like an island in the midst of the great Gangetic plain. Dominating the great waterway which leads from the borders of the Punjab to the Bay of Bengal, it has for centuries been the stronghold of the aboriginal tribe who sought refuge in it from the Aryan flood descending from the north-west on the fertile plains of Bengal. From his almost inaccessible stronghold, the Paharia looked down upon the coming and going of the Hindu, the Pathan, and the Moghul. Empires rose and fell before his very eyes whilst he, hating the foreigner of every race and creed, remained wrapped in his primitive barbarism, a hunter living on the produce of the surrounding forest, not to be starved into submission, because he had no need of the produce of the plains. His only dealings with successive invaders were when he swooped on the villages below, killing and robbing their inhabitants, or cutting off travellers and the camp followers of passing armies. Neither Hindu nor Mahomedan could subdue him by main force without extravagant loss.

Attempts to bribe the mountaineer with land around the mountain failed, for he did not care to cultivate, and the keeping of a bargain with the hated foreigner formed no part of his moral code.

At last appeared the British, whose fair complexion impressed the Paharia with an idea that they were of higher origin than the earlier conquerors. In Augustus Cleveland came a man who found a way to tame the savage, to enlist his sympathy, and to offer an outlet for his martial instincts. Some of the Paharias were enlisted as an irregular force, whilst an endeavour was made to isolate the rest in a ring of neutral territory, from which the Hindu and the Mahomedan of the plains were to be excluded. Much of Cleveland's good work was undone by a successor of sterner and less considerate temperament. The solution of the difficulty was finally found, about 1830, when a wandering branch of the Santals, another aboriginal tribe, appeared upon the scene and eagerly accepted the land below the hills which the Paharia, refusing for himself, made untenable for the plainsman. The Santal, an enthusiastic though uncivilised cultivator, recognised as a kinsman by the Paharia, formed an efficient buffer between the hillman and the inhabitants of the surrounding plain. The Santal, in turn, gave trouble in 1856, when he broke into rebellion directed against the peaceful penetration of the moneylender and the landgrabber.

It is with these two aboriginal tribes that Mr. Bradley-Birt chiefly deals. As men, they are perhaps more interesting to the ethnologist and the philologist than to the ordinary student of human nature, but the author has succeeded in enlisting such interest as we can spare to one tribe still in the purely agricultural stage, and to another which has scarcely as yet progressed beyond that of the hunter.

His picture of village life on, and at the foot of, the Rajmahal hills glows with local colour and swims in the atmosphere of the jungle and the plain. It was scarcely necessary for him to assure his reader that most of the book was written in camp, in the midst of the Paharias and the Santals. As one reads, one seems to inhale the fresh, crisp air of an Indian cold weather morning, or to pant in the heavy atmosphere of the forest as the line of Paharia hunters presses, shouting and slaying through the dense undergrowth.

FIG. 1.—A Primitive Mode of Irrigation. From Bradley-Birt's "Story of an Indian Upland."

Much that Mr. Bradley-Birt describes, or depicts in his photographs, is not peculiar to the Santal Parganas. The primitive mode of irrigation, with basket swung by two men, which forms the subject of the illustration here reproduced, is still practised by millions who have never heard of the Santals, or been within a thousand miles of their home. All over India the cultivator watches his crops at night from a rough platform raised on a ricketty scaffolding of bamboos. Sometimes it happens, in regions not unlike the Rajmahal hills, that the vigil ends in a tragedy, when the sleepy watcher is torn from his post by the man-eating leopard. But the inclusion of these incidents in no way detracts from the charm of the picture of simple village life, a life of agricultural labour tempered by feasting and dancing in seasons when there is no labour to be performed.

The Paharias' rude religion has drawn nothing from Hinduism or Islam. The Santal equally professes his separation from those creeds, but his love of pleasure has induced him to adopt some of the Hindu festivals, for instance the Jatra, which he celebrates in February.

[1] "The Story of an Indian Upland." By F. B. Bradley-Birt. Pp. xvi+354. (London: Smith, Elder and Co., 1905.) Price 12s. 6d. net.

The history of British administration in this wild tract, up to the time of the Santal rebellion of 1856, can scarcely be held up as a great example. As for the patriarchal system which still prevails, Mr. Risley, in an introduction which, from the pen of so great an ethnological authority, is somewhat disappointing, throws some doubts on its superiority to other methods of dealing with aboriginal tribes. Perhaps, in later years, Mr. Bradley-Birt's enthusiastic admiration of it may cool. As matters stand, his enthusiasm, and his evident sympathy with the simple peoples he describes, serve to enhance the charm of his work.

To the Anglo-Indian this volume will recall much that is pleasant; to the tourist, and even to the stay-at-home Englishman, it will afford a bright glimpse of native country life which is not to be found on the beaten track.

NOTES.

At the meeting of the Royal Society on May 18 the following were elected foreign members:—Prof. L. Hermann, Koenigsberg; Prof. H. A. Lorentz, Leyden; Prof. H. Moissan, Paris; and Prof. Hugo de Vries, Amsterdam.

The annual visitation of the Royal Observatory, Greenwich, will take place on Saturday next, June 3.

The international conference having for its object the establishment of an international institute of agriculture was opened in Rome on Sunday, May 28, in the presence of the King of Italy. On Monday the conference held a sitting at the Accademia dei Lincei, and the Foreign Minister, Signor Tittoni, opened the proceedings with an address.

The English Arboricultural Society has been granted permission by the King to change its name to the "Royal English Arboricultural Society."

Prof. J. N. Langley, F.R.S., will give one of the general lectures at the meeting of the Association of German Naturalists and Physicians, which will open at Meran on September 24. His subject will be "Recent Researches on the Nervous System."

A Reuter telegram from Portici states that Vesuvius has for some days been in active eruption. At 7 p.m. on May 27 the western side of the small terminal cone collapsed, and a large quantity of lava burst forth, which in an hour's time reached the base of the great cone, at Atrio Cavallo, one kilometer distant.

We learn from the *Board of Trade Journal* that the *Gaceta de Madrid* for May 11 contained the text of a Royal Order providing for the duty-free admission into Spain of instruments and accessories carried by foreign men of science deputed to observe the eclipse of the sun on August 30.

According to a Reuter telegram, dated New York, May 27, the Cunard liner *Campania* reports that she was in continuous communication with land, by wireless telegraphy, throughout her entire voyage from Liverpool. In mid-ocean she had simultaneous communication with America and Europe, a feat which had not previously been accomplished.

A correspondent of the *Times* states that in the early part of May enormous shoals of dead fish were thrown up for a considerable distance along the sea coast by Karachi The whole beach was strewn with dead fish, lying in some places five or six inches deep. The Port Trust authorities had to make arrangements for the removal and burial of these millions of fish. Captain Belton, of the steamship *City of Dundee*, on arriving at Karachi reported some very curious electrical phenomena about a hundred miles out to sea, repeated flashes of light being observed to pass over the surface of the ocean in a curious way.

An international congress for the study of radiology and ionisation will be held at Liège on September 12–14 inclusive. The congress will be divided into a physical section and a biological section. The former will be concerned with the physics of electrons, radio-activity and dependent transformations, meteorological and astronomical phenomena and their relation to ionisation and radio-activity. In the biological section the subjects to be considered will include the physiological properties of various radiations and of radio-activity, and their medical value and application. The method of procedure in this section will be determined upon by a special committee presided over by Profs. Bouchard and d'Arsonval. The other members of this committee are Drs. Béclère, Bergonié, Broca, Charpentier, Charrin, Danysz, and Oudin. There will also be a general committee, presided over by M. Henri Becquerel, to examine, classify, and decide upon such reports, papers, and notes as may be offered. The acting president of the congress is to be Prof. H. Kuborn, president of the Royal Medical Society of Belgium, and the general secretary, to whom all communications or contributions should be sent as soon as possible, is Dr. J. Daniel, rue de la Prévoté, 1, Brussels.

Mention has already been made of the recent visit of British physicians and surgeons to Paris, and the cordial and enthusiastic welcome extended to them by French men of science, as well as by the State and municipal authorities. Further particulars of the visit are given in the *British Medical Journal* of May 20. Among the numerous receptions arranged by the scientific and medical societies and by civil bodies of every kind to do honour and give pleasure to the British visitors, no meeting was more appreciated than that which gave the British men of science the opportunity of paying homage to the memory of Pasteur. On May 11 the visitors attended at the Pasteur Institute to witness the ceremony of placing a wreath upon the tomb of Pasteur in the crypt of the institute by Dr. J. Kingston Fowler, dean of the medical faculty of the University of London. Dr. Roux, the director of the Institute, conducted the visitors and a distinguished party of French medical men to the gates of the crypt, where Dr. Fowler delivered in French the speech referred to in Nature of May 18 (p. 63), in which he craved permission to place a wreath on the tomb of the master, who accomplished so much for science and for humanity, and to whose labours the institute is a fitting memorial. Dr. A. Waller, dean of the faculty of science of the University of London, followed with an eloquent eulogy, also delivered in French. He laid great stress upon the value to humanity of Pasteur's work in the direction of the infinitely little, and spoke of Pasteur as *le médicin de la médecine*. Dr. Waller maintained that in a thousand years' time historians will not speak much of the nineteenth century as remarkable for the invention of the locomotive and other mechanisms, but rather as the epoch in which Pasteur inaugurated so brilliantly the study of the infinitely small. The earnest speeches, and the impressive scene as the visitors passed before Pasteur's tomb in respectful homage to their master, made the occasion a memorable one. The evidence thus given of the reverence in which Pasteur's memory is held should help to cement the friendly relations existing between France and Britain, and to foster that spirit of mutual confidence—that comity of nations—which already exists in the world of science.

THE May number of *Museum News* (Brooklyn Institute) contains an interesting notice of specimens in the collection illustrating the now obsolete manufacture of tapa cloth in Hawaii and other Polynesian islands.

A PRELIMINARY report, by Dr. H. W. Conn, on the fresh-water protozoans of Connecticut, issued as Bulletin No. 2 of the Connecticut Geological and Natural History Survey, is illustrated by no less than thirty-four beautifully executed plates. Hitherto the American fresh-water representatives of these lowly organisms have been but little studied, and the present research is merely a prelude to a fuller account of their distribution and their relation to the purity of drinking water. Descriptions of species are altogether omitted in this report, and even the generic position of some of the forms mentioned is left more or less undecided.

IN connection with the preceding paragraph may be appropriately noticed Mr. D. J. Scourfield's address (delivered in December last) on fresh-water biological stations, which is published in the April issue of the *Journal of the Quekett Microscopical Club,* since this also deals with the effects of organisms on the purity of water used for domestic purposes. The gradual awakening of interest in the subject of the detailed study of fresh waters and their organisms is sketched, and the history of the establishment of stations for the purpose briefly described, special reference being made to the one founded by Mr. E. Gurney on Sutton Broad, Norfolk, in 1902. The lecturer concludes with remarks about what fresh-water biological stations should be, whenever the requisite financial means are obtainable.

AMONG other monographs on American invertebrates recently received is a revision of the beetles of the family Staphylinidæ included in the section Pæderini. In this article, forming No. 2 of vol. xv. of the *Transactions of the St. Louis Academy,* the author, Mr. T. L. Casey, points out that the taxonomic problem presented by these beetles is one of great interest in reference to the comparative morphology of the tribe. Genera from all parts of the world are included in the revision, but with the exception of the types of new generic forms, the only species catalogued are those inhabiting America to the northward of Mexico.

IN an article on the affinities of Equisetum in the May number of the *American Naturalist* Prof. D. H. Campbell comes to the conclusion that these archaic plants are related to ferns rather than to lycopods, and that both ferns and equisetums are probably divergent branches from a common ancestral stock. In the same issue Mr. D. D. Jackson discusses the movements of diatoms, many of which appear to be due to the evolution of oxygen gas produced by the activity of the chlorophyll in these organisms. Attention may likewise be directed to Mr. A. H. Clark's paper on the habits of the important West Indian food-fish known locally as "whitebait" or "tri-tri" (*Sicydium plumieri*).

IN the report of the delegates of the University Museum for 1904, published on May 16 as a supplement to the *Oxford University Gazette,* special attention is directed by the Hope professor of zoology (Prof. Poulton) to the increase in the insect collection and the work that has been accomplished, or is in progress, in connection with the insect collection, which is rapidly becoming one of the finest in the world. The most recent addition is the collection of 7000 British Microlepidoptera presented by Mrs. Bazett, of Reading, another splendid acquisition being the collection of Hymenoptera and Lepidoptera bequeathed by Mr. G. A. J. Rothney. The report also alludes to the recent decisive confirmation of the existence of three distinct mimetic types of female in a South African Papilio, and to the remarkable features presented by certain southern butterfly faunas, which are almost wholly of a northern type. The editing of the Burchell manuscript, and the identification of the specimens in the collection of the great traveller referred to therein, are also mentioned.

AMONG the more important articles in the issues of the *Proceedings of the Philadelphia Academy* for the current year, the following may be specially mentioned. To the January issue Mr. C. W. Johnson contributes an annotated list of the type-specimens of Cretaceous invertebrates in the collection of the academy, while Mr. H. W. Fowler gives the second instalment of a paper on new or little-known scombroid fishes. Later on Mr. H. Crawley discusses the movements of gregarines; and in the February issue Mr. H. A. Pilsbry describes a number of new Japanese marine molluscs. Both entomologists and morphologists will find much to interest them in an article by Dr. E. F. Phillips on the structure and development of the compound eye of the bee, while Mr. Crawley's preliminary notice of a new sporozoon (*Coelosporidium blattellae*) found in the croton-bug (*Blattella germanica*), and Mr. T. H. Montgomery's contribution to our knowledge of the spermatogenesis of certain spiders and remarks on chromosome reduction, will appeal to specialists in such matters.

A RECENT issue of the *Jenaische Zeitschrift* contains the report of an address delivered in June last before the Medical and Scientific Society of Jena by Prof. E. Haeckel on the progress of biology in that city during the nineteenth century. Confining himself chiefly to morphology, and dwelling specially on the various theories which have been advanced in regard to that of the vertebrate skull, the professor pointed out that in Jena the "science century" may be divided into three periods. The first of these, during which Schleiden advanced the cell-theory, extended to 1838; then followed an interval of twenty years, after which, in 1859, came Darwin's epoch-making theory of the evolution of species. After referring to the work of Blatt on embryology and development, the lecturer emphasised the morphological importance of the "vertebral theory of the skull" enunciated by Goethe and Oken in the first third of the century, and of Huschke's labours in connection with the development of the skull and the sense organs in the second third. A whole paragraph is devoted to Goethe's discovery of the premaxilla in man. Oscar Schmidt, Johannes Müller, Carl Gegenbaur, and the other great names associated for longer or shorter periods with Jena and its teaching, receive in turn their share of praise in this admirable historical address.

MM. CALMETTE AND BRETON have repeated the experiments of Loos and others on the transference of infection in ankylostomiasis through the skin. They find that the larvæ of both the human and the canine Ankylostoma pass with the greatest facility through the skin of the dog, causing infection of the animal (*Acad. de Méd.,* Paris March 24).

THE *Bulletin of the College of Agriculture of the Imperial University, Tokyo* (vol. vi., No. 4), contains several papers of interest on the value and use of artificial manures for various crops, and others on the flowering of the bamboo, on oxidases, on the determination of fusel oil, on a bacillus observed in flacherie, &c. With regard to flacherie (a destructive disease affecting silkworms), the conclusion is

arrived at that it is not caused by any special bacterium, but by several different species of common occurrence on mulberry leaves.

We have received part ii. of the reports of the commission appointed for the investigation of Mediterranean fever, part i. of which has already been noticed in NATURE (May 4, p. 17). Dr. R. W. Johnstone deals with the sanitary circumstances and prevalence of the disease in the Maltese Islands, but is unable to give any definite pronouncement on the mode of human infection. The facts do not indicate that dust, personal contact, or excretal pollution play an important part in the spread of the disease. Staff-Surgeon Bassett-Smith, R.N., details experiments on the saprophytic life of the *Micrococcus melitensis,* and Dr. Eyre on the virulence of this organism for the guinea-pig.

The Bulletins of the Bureau of Government Laboratories, Manila, several of which have from time to time been noticed in these columns, always contain matter of interest. No. 20, in five articles, discusses various diseases occurring in the Philippine Islands, and in No. 21 Dr. Strong deals with certain questions relating to the virulence of micro-organisms and their immunising powers. The conclusion is arrived at that a virulent cholera spirillum possesses a greater number of bacteriolytic and agglutinable haptophore groups, or these groups are endowed with a greater binding power for uniceptors and amboceptors than the avirulent. That is to say, virulent cholera microbes have a greater capacity than avirulent microbes for uniting with living cells and their products.

An article on roses by Mr. Jekyll in the April number of the *Bulletin of the Department of Agriculture, Jamaica,* warns growers against attempting to grow hybrid perpetuals in the island. First place is assigned to the tea and noisette sections, which produce good results except in so far as the sun is too strong for some, and a good selection of suitable roses may be made from the list which is given.

A FLORA of the islands of Margarita and Coche, lying off the coast of Venezuela, is being prepared by Mr. J. R. Johnston, but meantime he has published a list of new plants from these islands in the *Proceedings of the American Academy of Arts and Sciences* (April). A new genus, Anguriopsis, is formed having affinities with the cucurbitaceous genus Anguria. Among the new species are a Bactris—a palm with handsome foliage—two new orchids, and several trees, including a Capparis, a Cæsalpinia, and a Casearia. The new species are for the most part additions to genera or sections of the genera which are confined to tropical America.

One of the most fruitful lines of recent research in botany has been concerned with the investigation of fossil seeds, of which several species of Lagenostoma are the best known. The evidence in favour of referring these seeds to certain vegetative portions of Carboniferous plants, formerly regarded as fern fronds, formed the subject of Dr. Scott's presidential address to the Royal Microscopical Society, which is published in the April number of the Journal. The cycadofilicinean position assigned to *Lyginodendron Oldhamium,* which shows a sphenopteris type of foliage, was confirmed by the evidence which connected the same plant with *Lagenostoma Lomaxi.* Mr. Kidston's discovery of the fructification of *Neuropteris heterophylla* fixed the seed to another typical fern-frond, and recent research points to the production of winged seeds by a species of Adiantites.

In a sketch of the geology of Upper Assam (*Records Geol. Surv. India,* xxxi., part iv.) Mr. J. Malcolm Maclaren describes the region as a great plain, 320 feet to 500 feet above sea-level, bounded on the north-west by the eastern Himalayas and on the south-east by the Patkai ranges, while the head of the valley is closed in by the crystalline and metamorphic rocks of the Miju ranges. Upper Tertiary sandstones occur at a considerable height (maximum 6900 feet) on the Patkai and Himalaya ranges, but have not been observed anywhere on the heights of Miju. Attention is directed to the general uptilting and reversed faulting of the Tertiary rocks on either side of the great plain, and to the deflection in the trend of the Patkai range where it abuts against that of Miju. These features are attributed to earth stresses during the formation of the mountains. The author concludes that the Patkais and Himalayas, in their later growth at least, are of contemporaneous development, and that both are orographically and geologically distinct from the great meridional mountain system of Upper Burma, Tibet, and western China. In another article Mr. Maclaren deals with the auriferous occurrences of Assam. Gold was there worked in ancient times, and it is distributed in extremely small percentages throughout the alluvial gravels of the Brahmaputra; but the author is of opinion that only two or three localities are worthy of further prospecting, and that these are likely to yield comparatively small results. He believes that in Assam, as in most other parts of India, the climatic conditions that make for concentration of gold have always been absent. There never has been that even flow of waters confined within well-marked banks, that after a lengthened period results in a separation and local concentration according to specific gravity of the river-borne minerals in "leads" and "runs." On the other hand, there have been annual floods, varying so quickly in height, velocity, and direction that the slight local concentration of one year has been effaced by succeeding floods.

We have received vol. ii. of the year-book of the Austro-Hungarian Meteorological Observatory of Agram for the year 1902, a large folio publication containing fifty pages of tables giving detailed and summarised observations and results at a number of stations in Croatia and Slavonia. The size of the work is somewhat unwieldy, but the tables are very legible, and have been carefully prepared on the plan of the international scheme for meteorological publications. Hourly readings, and hourly and daily means, are given for Agram.

The recently published annual *Journal of the Scottish Meteorological Society* (third series, Nos. 20 and 21) contains an interesting discussion of the rainfall of the Ben Nevis observatories, by Mr. Andrew Watt. The measurement of precipitation on the summit was attended with great difficulties; the high wind velocities, at an altitude of 4400 feet, made the registration of snow (which mostly falls between October and May) and even of rain somewhat uncertain. The tables show the falls at the upper and lower stations for the nineteen-year period 1885–1903. The average annual rainfall at the summit was 160·8 inches, and that at the foot 78·6 inches; in individual years the amounts varied from 49 per cent. above to 33 per cent. below the mean values on the summit, and from 45 per cent. above to 23 per cent. below at the lower station.

With regard to daily range, the author states that, speaking very generally, rain falls more frequently, but less heavily, by night than by day, at the foot of the mountain; whilst on the summit the variations are less pronounced, but, on the whole, are in sympathy with those at Fort William. On the top of the mountain falls of 4 to 6 inches in a day were occasionally recorded.

A GOOD oil-immersion lens at a moderate price has long need has been met by Mr. Gowlland, of Selsea, who has been wanted by histologists and bacteriologists. This produced an objective of 1/12-inch focal length and 1·30 numerical aperture at a price of 2*l*. 15*s*. It is an admirable piece of apparatus, and is well corrected for spherical and chromatic aberration. We have tested it on a number of objects, and can recommend it as thoroughly efficient. It is claimed by the maker that it has good photographic qualities.

IN a paper published in the *Gazzetta* for April 3, Dr. Italo Bellucci proves that the so-called hydrated platinum oxide, $PtO_2,4H_2O$, is in reality a platinic acid of the structure $H_2Pt(OH)_6$, corresponding with chloroplatinic acid H_2PtCl_6, and forming a series of well defined salts of the type $M_2Pt(OH)_6$. In a second paper, written in conjunction with N. Parravano, the metallic stannates and plumbates are shown to be derived from similar acids, $H_2Sn(OH)_6$ and $H_2Pb(OH)_6$, whilst the three salts $K_2Pt(OH)_6$, $K_2Sn(OH)_6$, and $K_2Pb(OH)_6$ are strictly isomorphous. The views brought forward are of considerable importance from the standpoint of the systematisation of inorganic chemistry, and as showing that so-called water of crystallisation may in many instances play an important part in molecular structure.

SINCE Lord Rayleigh published in 1897 his interesting results on the oxidation of atmospheric nitrogen by an electric arc, many attempts have been made to devise a practical method of synthesising nitric acid from the gases of the atmosphere. Owing, however, to the fact that nitric oxide is formed by an endothermic change and to the early production of a condition of equilibrium when little oxidation has occurred, the processes hitherto published have been far from economical. In the *Gazzetta* for April 3 E. Rossi describes how the efficiency of such methods may be greatly increased by working with air under a very great pressure. The heating is effected by means of an incandescent resistance similar to the filament of a Nernst lamp, and the nitric oxide is absorbed by concentrated sulphuric acid within the interaction chamber, as fast as it is produced, so as to obviate an equilibrium.

IN the *Verhandlungen* of the German Physical Society (vol. vii. p. 78) L. Graetz replies to the objections raised by Profs. Precht and Otsuki (compare NATURE, vol. lxxi. p. 468) against his view that hydrogen peroxide gives rise to a special radiation capable of affecting a photographic plate. He considers that a substance so comparatively non-volatile as hydrogen peroxide, which has a vapour tension less than that of water, and can be concentrated by allowing a current of air to pass through it, cannot be conceived as directly permeating sheets of celluloid and gelatin. Again, the extreme readiness with which hydrogen peroxide is decomposed catalytically by metals makes it improbable that it would pass as such through minute holes in thin metallic plates. In a second communication, published in the same periodical (vol. vii. p. 163), Profs. Precht and Otsuki maintain their original contention by emphasising the minuteness of the quantity of hydrogen peroxide necessary to affect a photographic plate. The action of the peroxide on sensitive plates has since been discussed in detail by Prof. Otsuki in a paper read before the Society of Chemical Industry on May 1.

A HERBERT SPENCER lectureship has been founded at Oxford by a Hindoo gentleman who is a Master of Arts of Balliol College. The first lecture was delivered on March 9 by Mr. Frederic Harrison, and has been published by the Clarendon Press. It is appreciative, but not—lecturer or printer has surely blundered in regard to the prefix—"an apodictic eulogy." Mr. Harrison's chief criticisms of the synthetic philosophy are:—(1) that, laying all the emphasis on evolution, it disregards the laws of stability and permanence, such as are manifested chiefly in the inorganic sciences—which it accordingly passes over; (2) that its attempt to reduce all manner of sciences under the same laws only succeeds because it neglects the peculiarities which make any one science or set of sciences incommensurable with others, as, *e.g.*, the human sciences are with the non-human. But the lecturer readily admits that Spencer did not allow himself to be confined by the materialistic dogmas with which he set forth, and that while "Philosophy never opened with aspect more physical, it never insisted more imperatively on the law of Justice from man to man, on the supreme duty of Altruism."

THE thirty-fifth of the privately printed opuscula issued to the members of the Sette of Odd Volumes is entitled "The Early History of the Royal Society." The author of this brochure is Mr. Henry B. Wheatley, sometime clerk to the Royal Society, who has succeeded in writing a very interesting account of the early years of our national association of men of science. Mr. Wheatley shows that Charles II.—"Founder, Patron, and one of the Royal Society of London for improving Natural Knowledge"—took a genuine interest in the advancement of the society. "True he did not give any money, but then money was never very plentiful with His Majesty. He was always ready to assist with his name and influence. His interest doubtless made the Society the fashion." Doubt is cast on the truth of the story of the paradox put forward by Charles II. concerning the weights of respective bowls of water with or without fish in them. A suggestion of Sir William Petty, the inventor of the double-bottomed boat, as to the society's anniversary, is worth repetition. Aubrey writes:—"I remember one St. Andrew's day I sayd methought it was not so well that we should pitch upon the Patron of Scotland's day. We should rather have taken S. George or S. Isidore, a philosopher canonized. No, said Sir William Petty, I would rather have had it been S. Thomas's day." Objections were on one occasion made to Charles II. that a member recommended by him for election was a shopkeeper. By way of reply the King "gave this particular charge to his Society, that if they found any more such tradesmen they would be sure to admit them all, without any more ado." Mr. Wheatley records many more quaint stories and odd incidents associated with the society's earlier years, and his paper will excite lively interest in all scientific readers who are able to obtain a copy of it.

MR. HENRY FROWDE has published in pamphlet form the Robert Boyle lecture delivered by Prof. H. B. Dixon, F.R.S., before the Oxford University Junior Scientific Club in 1903, on the nature of explosions in gases.

NEW editions of "Half Hours with the Microscope," by Dr. Edwin Lankester, and "The Preparation and Mounting of Microscopic Objects," by Mr. Thomas Davies, have

been published by Messrs. C. Arthur Pearson, Ltd. Dr. Lankester has made important additions to his book descriptive of the compound microscope and its accessories, and has incorporated a chapter by Mr. F. Kitton on the polariscope and its uses. Dr. John Matthews has edited the second book, and has made several alterations and additions, among the latter being a prefatory chapter dealing with preliminary histological manipulation.

THE *Bulletin de la Société des Naturalistes de Moscou* (1904, Nos. 2 and 3) contains the following papers:—Four notes on the crystalline forms and optical properties of various salts.—On the theory of endosaprophytism with lichens, by A. Elenkin. A defence of the latter as against the mutualistic theory, with a bibliography of the literature of the subject (in German).—The Jurassic corals of the Sudagh, by A. Missuna (with plates). In a total of 108 species, 46 are new for the Crimea, and 14 new species are described. The Crimean coral-fauna has its nearest relative in the Jurassic fauna of Switzerland (this paper is in German).—Materials for the algology of Lake Baikal, by V. Dorogostaïsky (with a plate). Results of a two years' study of the algæ in Lake Baikal and its affluents. A list of 350 species is given, a few of them being new (this paper is in French).—History of development of the excre tory system with the Amphibiæ, D. P. Filatow (in German, with a plate).—The same number contains a fine portrait of Prof. T. A. Bredikhin, and a biographical sketch of the late Moscow astronomer, including a sketch of his theory of comet tails, by P. K. Sternberg.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE:—

June	2.	Venus at maximum brilliancy.
,,	11.	13h. 3m. Minimum of Algol (β Persei).
,,	12.	8h. 22m. to 9h. 24m. Moon occults l^2 Virginis (mag. 4·9).
,,	13.	Saturn. Outer major axis of outer ring=40″·87; outer minor axis of outer ring=6″·03.
,,	,,	9h. Mars in conjunction with moon, Mars 6° 14′ S.
,,	14.	9h. 52m. Minimum of Algol (β Persei).
,,	15.	Venus. Illuminated portion of disc=0·365; of Mars =0·938.
,,	21.	15h. Sun enters Cancer, Summer commences.
,,	,,	22h. Saturn in conjunction with Moon, Saturn 1° 29′ S.
,,	23.	23h. Uranus in opposition to the Sun.
,,	27.	14h. 48m. to 16h. 33m. Transit of Jupiter's Satellite III. (Ganymede).
,,	29.	14h. 10m. to 15h. 1m. Moon occults θ^2 Tauri (mag. 3·6).
,,	,,	14h 15m. to 14h. 56m. Moon occults θ^1 Tauri (mag. 3·9).

A REMARKABLE VARIABLE STAR.—In a note published in No. 4017 of the *Astronomische Nachrichten* Prof. E. C. Pickering states that the light-changes of the variable star 154428, R Coronæ Borealis, are unlike those of any other known variable. A series of observations, made by Mr. Leon Campbell, showed that during the period March-September, 1903, the magnitude underwent remarkable changes between the limits 6·0 and 9·4. Since then until March of the present year it remained stationary at 6·0 m. The unusual character of the changes during April and May is shown in the following table:—

1905	Mag.	1905	Mag.
April 1	6·0	May 1	11·4
11	7·3	7	12·5
21	8·4		

Observations with large telescopes are now desirable in order to see whether or not this object disappears entirely. It is easily recognised on the Harvard "Map of the Sky," plate No. 18 (118·75), and is nearly equidistant from γ, δ, and ϵ Coronæ.

RADIAL VELOCITIES OF THIRTY-ONE STARS.—For the past ten years line-of-sight observations have been made at the Emerson McMillin Observatory (Columbus, Ohio), but Prof. Lord has now arrived at the conclusion that, as so many better equipped observatories, situated in more favourable atmospheres, are engaged in this work, it seems advisable to discontinue the observations there and direct the available resources into some other channel of research for which they are better equipped. Consequently he has collected all the results obtained during the decennary, and has published them in No. 4, vol. xxi., of the *Astrophysical Journal*. Complete catalogues of the plates taken and of the standard lines employed, and the collected results, are embodied in his communication. Amongst the thirty-one stars dealt with there occur α_1 Cassiopeiæ, Aldebaran, α Arietis, α Persei, Capella, Pollux, Dubhe, Arcturus, β and γ Cygni, and δ Cephei.

MAGNITUDES OF NOVA PERSEI AND NOVA GEMINORUM.—In No. 4017 of the *Astronomische Nachrichten* Prof. A. A. Nijland publishes the results of a number of magnitude observations of Novæ Persei and Geminorum. The observations of the former covered the period November 15, 1901, to January 13, 1905, and the figures given show frequent increases of brightness, which were, however, very small. A gradual decrease of magnitude underlies these minor fluctuations, and on January 13 the Nova was of magnitude 10·74.

The Nova Geminorum observations extended over the period March 27, 1903, to December 30, 1904, and on the latter date the magnitude recorded was 13·3, more than 2·7 magnitudes fainter than Nova Persei on the same date.

OXFORD UNIVERSITY OBSERVATORY.—Prof. Turner's report of the work done at the Oxford University Observatory during the twelve months ended April 30 informs us that the Oxford work in connection with the International Astrographic Catalogue is at last within measurable distance of publication. The measures and reductions were completed last year, and the whole thing is now ready to print. What is still more satisfactory, the university has set aside 1000*l*. for this purpose, and this is to be supplemented by a similar contribution from H.M. Government.

The stereo-comparator has been used to compare some of the newer with some of the older plates, but, so far, nothing of importance has been discovered; more time will be given to this work when the coming eclipse is past and the Oxford contribution to the International Catalogue is safely in the press. As some of the earlier plates for the catalogue are less satisfactory than the later ones, they are being duplicated, and the new ones are being measured and reduced as opportunity occurs. An expedition from the observatory, comprised of Prof. Turner and Mr. Bellamy, will observe the total solar eclipse of August next in Egypt.

VARIATIONS OF LATITUDE.—The provisional results of the work accomplished by the International Latitude Service during 1904 are given by Prof. T. Albrecht in No. 4017 of the *Astronomische Nachrichten*. The results obtained at the six stations employed in the service are grouped, and the variation of the momentary from the mean pole during the years 1900–4 is graphically shown. From this curve it appears that the year 1904 was marked by a diminution in the amplitude of the variation.

NEW REFRACTION TABLES.—Appendix ii., vol. iv. (second series), of the *Publications of the U.S. Observatory* contains a number of reduction tables for transit-circle observations compiled under the direction of Prof. Eichelberger. All of them, except the refraction tables, are of no use at any other observatory, but these may be found useful by other transit observers. They consist of nine separate tables, in which the logarithms of the various arguments necessary for determining the exact refraction correction for each minute of apparent zenith distance from 0° to 85° are given. An example which precedes the tables clearly illustrates the method of using them. The tables are based upon those of Pulkowa.

ISLANDS FOR WEATHER FORECASTING PURPOSES.

THE aim of meteorology from a practical point of view is the forecasting of the amount of rainfall and the approach of storms.

The former will tell us whether we may expect high river flows producing floods and much damage, an average amount of water for successful crop production, or a deficiency of rain which might result in a disastrous drought and possibly a famine. In the case of storms, a means will be afforded of saving many lives and ships, and also, probably, much property ashore.

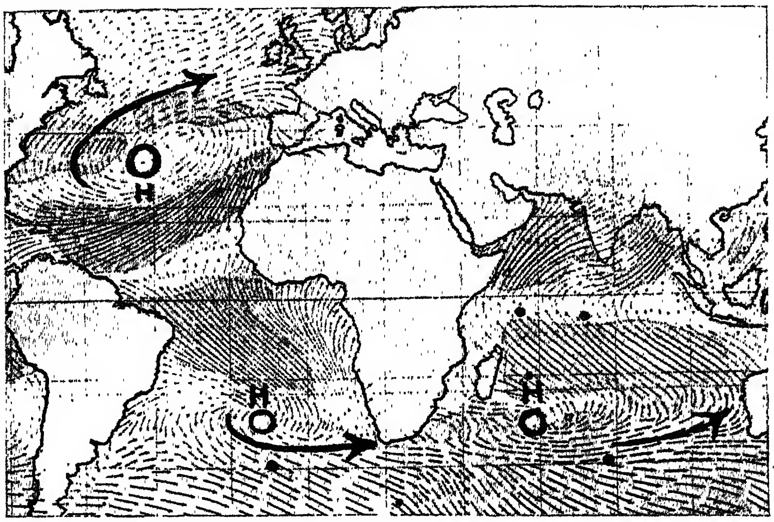


FIG. 1.—The wind system during summer in the northern hemisphere and winter in the southern hemisphere. The black dots represent islands, and the letter H the centres of regions of high pressure or anticyclonic areas.

The study of the weather, therefore, should be fostered to its fullest extent, and every advantage should be taken of means which will bring us nearer the goal of satisfactory forecasting.

Investigations carried out during the last decade have indicated the importance of each weather bureau extending its area of inquiry beyond the region for which it is making its forecasts. Needless to say, many of these institutions have for some years been in telegraphic communication with outlying stations. Thus, for instance, the Indian Meteorological Service receives information from a station so far distant as Mauritius, while the U.S. Weather Bureau utilises valuable observations by telegraph from stations in the West Indies, Azores, Europe, &c.

It is important to bear in mind that rain-bearing winds are those that have passed over large stretches of water, and that the rainfall of a country is deficient or well supplied with this commodity according to its geographical position in relation to the oceans or inland seas, mountain ranges, and the prevailing winds. It is for these reasons that the nearer the coast is approached from the centre of any continent, the greater becomes the rainfall. Thus, for instance, the interior of Australia, the Sahara, the Arabian Desert, Tibet, &c., are all very dry areas.

For forecasting purposes, therefore, attention should be, and in many regions is, paid to the region from which the prevailing winds come, due consideration being given to the particular barometric system of which the wind forms part.

From the above the important functions of islands conveniently situated become obvious. It is not, however, every country bordering on the ocean that is blessed with such an island in the direction of the prevailing wind, and the British Isles, in consequence, suffer very much from this very defect. In Great Britain the main rain-bearing wind is that from the south-west. In summer this forms part of a large anticyclonic system situated in mid-Atlantic towards the south-west (see Fig. 1), while in winter it is a portion of a cyclonic system the centre of which is near Greenland (see Fig. 2). With no islands in the track, the only meteorological information that is at once useful is that which can be gathered from messages sent by the Marconi system of wireless telegraphy from steamers *en voyage*. British weather forecasters are thus undoubtedly heavily handicapped by the lack of some permanent outlying source of information in this region.

Mention has already been made of the use of islands by the United States and India. The latter is particularly fortunate, for Mauritius, Seychelles, Chagos (marked with dots in the figures), and other islands are all conveniently situated to render information if necessary.

Another region which very probably would gain considerably by utilising observations made at island stations is South Africa.

In a previous number of this Journal (vol. lxxi. p. 342, February) Mr. E. Hutchins, Conservator of Forests, Cape Town, gave an excellent account of the general weather conditions in this region. He pointed out that South Africa lies on the border of the south-east trade area. In summer, from Cape Town to the Zambesi, the country comes entirely under the influence of the south-east trade winds. In winter, on the other hand, the southern portion of Cape Colony is subject to "another type of weather, due to the passage of storms from the South Atlantic, the

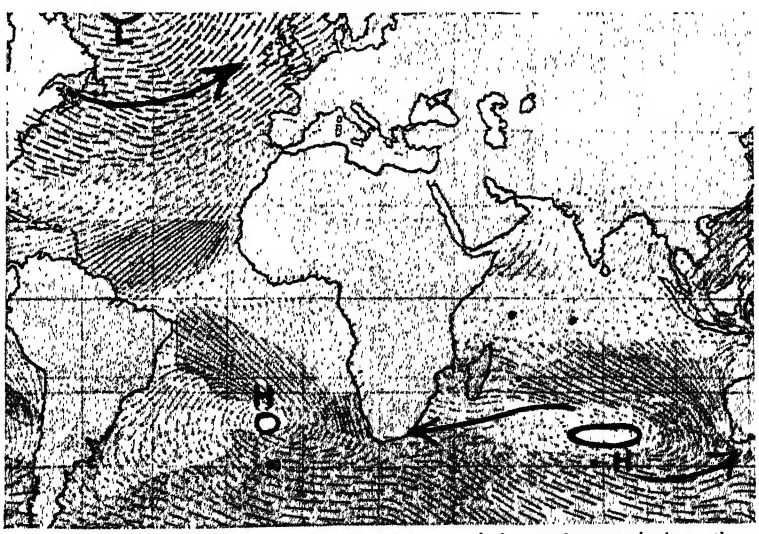


FIG. 2.—The wind system during winter in the northern hemisphere and summer in the southern hemisphere. Notation as in Fig. 1. The letter L indicates the centre of a low pressure or cyclonic area.

'roaring forties' of mariners." He further directs attention to the need of distinguishing between these two weather systems, which play distinct parts in the meteorology of this region. A study of the accompanying two figures will indicate the importance of the islands of Tristan d'Acunha and Gough (indicated by a black dot towards the south-west), and also of Mauritius (the dot east of Madagascar). The two former islands lie in the wind system pertaining to the anticyclonic (high-pressure) area on the west, the centre being indicated by the letter H, while Mauritius, situated to the east of South Africa, is in the south-east trade area in the system formed by the high-pressure (anticyclonic) region, the centre of which is marked also with an H.

By observing the general trend of the air currents indicated by the large arrow, it will be seen that for the winter season in South Africa (Fig. 1) meteorological observations made in either Tristan d'Acunha or Gough Islands would undoubtedly render valuable aid to the weather forecasters.

In the case of the summer months (Fig. 2) there is no conveniently placed island that could furnish equal assistance, but it seems very possible that use could be, and most probably has been, made of the observations at Mauritius for determining the strength of the south-east trade current which impinges on the African coast at this time of year. For forecasting purposes Mauritius, and possibly Rodrigues, would have greater value for regions further up the African coast.

Unfortunately, the Amsterdam and St. Paul islands (marked with one dot) lie too far south and east to serve as useful outlying stations for South Africa. On the other hand, these islands should be undoubtedly utilised by the Australians.

An examination of the accompanying figures indicates the relative positions of the Australian continent and this large southern Indian Ocean wind system. These islands will thus be seen to be right in the track of the current which strikes the south and west coasts of Australia, and should form ideal out-stations for gauging the general condition of this wind system.

That the prevailing winds on the west coast of Australia come from a southerly direction is indicated in the following table, which gives the number of times the wind has blown from each point of the compass at the Perth Observatory during the year 1902, the readings being taken eight times a day :—

N.	98
N.N.W.	51
N.W.	73
W.N.W.	67
W.	92
W.S.W.	113
S.W.	232
S.S.W.	432
S.	425
S.S.E.	245
S.E.	194
E.S.E.	121
E.	157
E.N.E.	139
N.E.	159
N.N.E.	98

Another table shows that the resultant direction of the wind, at the same observatory for the same year, was south for the months January to April and October to December inclusive.

There seems every reason, then, to hope that the utilisation of information from one of these islands for several months in the year would in time amply repay the initial cost and maintenance of the station.

It is not without interest to remark that the air current which passes the west coast of Australia in July (that is, in winter in Australia) becomes later the south-east trade wind of the Indian Ocean, and eventually reaches the Indian area in the form of the south-west monsoon in the summer months of the northern hemisphere. In the months about July, Western Australia is thus apparently closely connected, meteorologically speaking, with India, but in the months about January the connection is between Australia and South Africa.

The natural deduction to be made from the above is that the meteorological services of all these countries should be closely in touch with each other. Their combined efforts will certainly considerably increase our knowledge of the meteorology of this vast region, and each will benefit by this mutual interchange of information.

Although mention has only been made of one or two instances in which the employment of islands as meteorological stations would most probably be rewarded with practical results, there are other countries that might equally profit by adopting the same principle.

It is, however, important for the study of world meteorology that many islands should be employed as observing stations. They may not be very ideal places for observers to live in, but a change every few months, and the adoption of self-recording instruments, would possibly simplify matters. Where cables are lacking, and the island in question is of great meteorological importance to some continent, wireless telegraphy might be employed with advantage. WILLIAM J. S. LOCKYER.

AN OPTICAL CONGRESS AND EXHIBITION.

THE aims of the optical convention, which was opened at the Northampton Institute, Clerkenwell, on Tuesday, May 30, are to increase the interest taken in optical science in this country, to promote an improvement in technical education in optical matters, and to aid the development of the British optical industry. In his address, the chief part of which is subjoined, the president, Dr. R. T. Glazebrook, F.R.S., after explaining the origin of the proposal to hold a convention, and the steps taken to realise it, gives an outline of the history of optical progress during the past two hundred and fifty years with the view of illustrating the close union which has existed between theory and practice at times of marked progress, and of showing how each has reacted on the other in assisting this progress. The programme of the convention includes meetings for papers and discussions, which will be subsequently published in a volume, and an exhibition of optical and scientific instruments of British manufacture, with a catalogue which is intended to serve as a work of reference illustrating the productions of opticians in this country. A description of some of the exhibits follows the president's address abridged below; and an article on the nature and matter of the papers and discussions will appear in these pages after the close of the convention.

PROGRESS OF OPTICAL SCIENCE AND MANUFACTURES.[1]

The study of optics is a fascinating one, and its history full of interest. I do not propose to-night to attempt to cover the whole ground, but to ask you to look at one or two special periods during which, it seems to me, theory and practice reacted on each other in a marked manner, and to consider what lessons we may draw as to the relation which should in these days of ours subsist between the two.

For this purpose I might go back to very early days. Ptolemy in his attempt to discover the laws of refraction —and wonderfully good the attempt was, as we know now —Archimedes with his burning glass, if, indeed, he ever made it, had both practical aims in view. But we will start to-night nearer our own time. The end of the seventeenth century is such a period. The telescope was invented about 1608, the microscope at rather an earlier date, about 1590, both, probably, in Holland.

Galileo, hearing of this, made his first telescope in 1610. In 1611 Kepler, in his "Dioptrica," described the astronomical telescope with one or more convex lenses as the eye-piece; with this exception, up to Descartes's book on "Dioptrics" in 1637, no other form of telescope but Galileo's was known. The law of refraction was first enunciated by Snell in 1621.

Thus by the year 1660 the importance of the telescope to the astronomer was fully appreciated, and its limitations were being realised. In 1663 Gregory published an account

[1] From the inaugural address delivered before the Optical Convention on May 30 by the president, Dr. R. T. Glazebrook, F.R.S.

of the first reflecting telescope designed to meet some of these defects, and about this time two men, whose work has left indelible marks on the science, were led to study it in a great measure from their interest in astronomy—Christian Huyghens, who lived from 1629 to 1695, and Isaac Newton, 1642 to 1727.

Huyghens was the discoverer of the wave theory and of the law of double refraction, but he was also a skilled mechanic, and he worked himself at grinding his lenses and erecting his telescopes. He realised from a consideration of the theory that many of the most marked defects were due to the fact that the rays from a distant star traversing the various parts of the lens were not brought to a focus at the same point on the axis, and that for a lens of given aperture this axial aberration decreased rapidly as the focal length increased. The magnification of the telescope depends on the ratio of the focal length of the object glass to that of the eye-piece. Hence by keeping this ratio constant, and increasing both focal lengths in the same proportion, the magnification could be maintained and the spherical aberration decreased.

Thus he was led to make lenses of 120 feet focal length. Tubes for such instruments could not be produced, and they were mounted on the top of tall poles and moved from below by ropes. With one of these telescopes, which he afterwards presented to the Royal Society, he discovered Saturn's rings and its fourth satellite. In this case the desire to improve an instrument caused an appeal to theory, and theory led the optician to make a real advance. The advance, it is true, was an inconvenient one, and the defects, as we shall see, were not entirely due to spherical aberration, but the fact remains.

In another branch of instrument making Huyghens is famous for applying science to manufacture. His treatise "Horologium Oscillatorium," which discussed most ably many problems of motion, was long the standard work on clocks, and he was the first to bring into practical use, in 1657, the pendulum as a regulator for time measurements, though according to Sir E. Beckett the first pendulum clock actually made was constructed in 1621 by Harris, of London, for St. Paul's Church, Covent Garden.

In 1665 a posthumous work of an Italian Jesuit, Francis Maris Grimaldi, entitled "Physico Mathesis de Lumine, Coloribus et Iride aliisque annexis," was published at Bologna. It contains some notable observations, particularly the discovery of diffraction.

Newton, who in the previous year had taken his B.A. degree at Cambridge, purchased a prism at Stourbridge Fair in 1666 "to try therewith the celebrated phenomena of colours," and to repeat some of Grimaldi's experiments. During that year also he had applied himself to the grinding of "Optic Glasses of other figures than spherical." He was already interested in astronomy, possibly had already made, but not confirmed, his great discovery. Writing to Halley in 1686 about some of the controversies which followed the publication of the "Principia," he says:—"But for the duplicate proportion I gathered it from Kepler's theorem about twenty years ago."

The celebrated apple is supposed to have fallen in his mother's garden at Woolsthorpe, in Lincolnshire, in 1665, where he was driven by the plague, and the story has some authority. It is stated to be the fact by Conduitt, the husband of Newton's favourite niece; it was told by Mrs. Conduitt to Voltaire, and the tree from which it was said to have fallen was seen by Sir David Brewster in 1820.

Various suggestions have been made, for the reason why the discovery that the same cause which produced the apple's fall also maintained the moon in her orbit was not published for many years; the true one is probably due to Dr. Glaisher, who pointed out that it was necessary to know the attraction not merely between two particles of matter, but between two spherical bodies of large size, and that this problem was not solved until much later; but, be this as it may, we are sure that in 1667 Newton was an astronomer, and realised the necessity for accurate astronomical observations, and all that the improvement of the telescope meant to astronomers.

Now his experiments with the prism in 1666 led to the discovery of the spectrum; little was known about colours at that time, and Dr. Barrow's "Treatise on Optics," published with Newton's help in 1669, contains very erroneous views; but some time shortly after that date Newton was able to draw the important conclusion that white light is not homogeneous, but consists of rays some of which are more refrangible than others; the pictures of the spectrum, so familiar to us in numerous text-books, come from Newton's "Optics," published first in 1704, though his discoveries as to the analysis of white light were laid before the Royal Society in various papers in 1671, and were given in lectures on optics as Lucasian professor in Cambridge in 1669, 1670, and 1671.

The bearing of all these physical experiments and researches on the practical manufacture of the telescope was at once obvious; the lenses behave like prisms, and decompose the light into its constituent colours. No alteration of shape will remove this entirely, and Newton was driven, too hastily as we know now, to the conclusion that the refracting telescope could not be greatly improved; its defects were inherent in the refraction of light.

The defect, however, does not exist in images formed by reflection, and he came to the conclusion that optical instruments might be brought to any degree of perfection imaginable provided a reflecting surface could be found which would polish as freely as glass and reflect as much light as glass transmits, and provided a method of communicating to it a parabolic figure could be found. In 1668 he thought of a delicate method of polishing by which he believed "the figure would be corrected to the last," and the Newtonian reflecting telescope was the result. An instrument made with his own hands is now in the possession of the Royal Society, and the many noble instruments which have added so greatly to advance our knowledge of the stars are the direct outcome of Newton's experiments with the prism and the deductions he drew from them.

But these experiments convey another lesson, for Newton, misled by his observations on dispersion, decided, wrongly, as we know now, that achromatic lenses were impossible, and that the colour defects must always exist in reflecting instruments; and as a result attempts to improve these instruments were almost in abeyance for nearly ninety years. Two or three achromatic telescopes were made by Mr. Hall about 1730, but it was not until 1757 that Dollond re-invented this instrument and commenced the regular construction of such lenses.

Thus the discoveries of Huyghens and of Newton reacted powerfully on the instruments of their day. Indeed, in each of these two instances the discoverer and the instrument maker were the same person. Such a combination may be less possible now; still, there are mathematicians skilled in the theory of optics and opticians skilled in the practice of their art.

The Optical Convention aims at coordinating the efforts of the two. But if 200 years ago the progress of the telescope was determined by the advance of optical theory, theory itself was no less indebted to the interest in instruments and observations thus aroused for the progress that took place.

Huyghens was the founder of the wave theory, though the labours of Young and the genius of Fresnel were necessary before Newton's rival theory of emission was displaced.

For nearly 100 years after the date of Newton's "Optics" progress was slow. The world was occupied in assimilating what he had taught. English mathematicians, overawed, perhaps, by his transcendent greatness, employed themselves in expounding his teaching. In England, at any rate, the emission theory was supreme, and few, if any, questioned his dicta as to the impossibility of achromatism.

But a change came with the new century. Thomas Young, 1773–1829, was the first in his various papers between 1801 and 1811 again to direct attention to Huyghens's work, and to place on a firmer basis the ground-work of the wave theory. He it was who established clearly the principle of the superposition of waves, and showed how interference may be explained by it.

Young's work, however, would have been incomplete without Fresnel (1788–1827), who re-discovered for himself the principle of interference and extended it to explain diffraction, besides enunciating his theory of double re-

fraction and deducing the well known expressions for the intensity of the light reflected from or transmitted by a transparent surface.

Young, in his "Lectures on Natural Philosophy," illustrated in an admirable way the applications of optical theory to instruments. Fresnel was an engineer by profession attached to the service of the bridges and roads, and as such was the inventor of the arrangements of lenses employed in the French lighthouses.

The discoveries of these two men changed the whole of the theory on which the construction of optical instruments is based; it is idle to attempt to explain the action of a microscope, the resolution of a double star or of the fine lines of the spectrum, to discuss the conditions for such resolution, or, instead, to attempt the construction of any of the more delicate of the beautiful apparatus about us without clearly understanding the fundamental laws discovered by these two, and verified with marvellous skill by Fresnel in his country home in Normandy, not by the aid of modern apparatus, but by such means as his own hands, aided by the skill of the village blacksmith, could construct; and though it is true that only recently have we appreciated the full importance of the wave theory in its bearing on the construction of optical instruments, it is the fact that without their labours and the work of those who followed in their path few of the modern discoveries of the astronomer, few of the results which the skilled optician of to-day has arrived at, would have been possible. The object glass of a microscope, the lens of a camera or a telescope, have reached their present perfection because men have been found who could apply to the art of lens grinding the highest teaching of Young and of Fresnel.

In the earlier years of the last century Englishmen were well to the fore in this work. In astronomy the labours of the two Herschels are well known, and though, perhaps, the success of the elder Herschel was due rather to his mechanical skill than to a profound knowledge of optical theory, Sir John Herschel advanced in no small measure the application of theory to practice.

At a somewhat earlier date Fraunhofer, of Munich (1787–1826), a contemporary of Young and of Fresnel, had realised the fact that the development of the achromatic lens "depended on the exact determination of refractive indices, and that the chief difficulty in that determination lay in the difficulty of obtaining homogeneous radiations to serve as standards" (Schüster, "Theory of Optics").

For these he used the dark lines of the solar spectrum, originally observed by Wollaston, and in this we have an example of the manner in which practical needs react to assist in the advance of science, for from these observations springs the whole of spectrum analysis and all that is involved in that.

Thus theory and practice progress together; each alone carries us but a short way, but the judicious use of hypothesis and reason, supported by the verdict of experiment, carries us on to new knowledge, and brings us nearer to the truth.

Until after the middle of last century we in Britain took our full share in promoting this advance. We might add to the names already mentioned those of Sir George Airy and of the distinguished men who, in the first half of the century, adorned Trinity College, Dublin, notably Sir William Hamilton.

Sir George Airy gave, about 1802, an account of the aberration of the lens of the camera obscura of the utmost value to the early designers of the photographic lens, while Sir William Hamilton's essay on the "Theory of Systems of Rays" contains the essence of all that is needed to calculate to a high degree of accuracy the aberration of such a lens.

But at that date photographic lenses were not thought of, and when Daguerre announced his invention in 1839 the work of Airy and of Hamilton was forgotten. Thus to quote, as I did lately in the Traill Taylor lecture, from the recent work of Dr. M. von Rohr.

"The important signification of Airy's writings for photographic optics does not seem to have been appreciated until a later date. Although they exercised an influence on English text-books, like that of Coddington, they seem unfortunately never to have become known in wider circles on the Continent. It appears, then, that the theoretical opticians of later years to whom his investigations into the astigmatic deformations of oblique pencils would have been of great interest did not base their work on that of Sir G. B. Airy," while Sir W. Hamilton's paper remained unnoticed by the optician until Finsterwalder directed attention to it, and another distinguished German, Prof. Thiessen, quite lately put his results into an accessible form.

There was a divorce between theory and practice in England. The importance of Daguerre's discovery was at once realised, and English opticians set to work with no small success to develop the lens and to make it perfect, and splendidly in many ways they performed their task; but the work was empirical. A certain amount of progress was possible, and was achieved, but without the guidance of well founded theory the progress could not be for long.

The learned Transactions of the Cambridge Philosophical Society and of the Royal Society of Dublin were perhaps the last places to which the practical optician would apply for help, and so it came about that because the opticians of another nation first recognised that a full knowledge of the action of a lens on the light that traverses it was a condition precedent to further truth, for some years past the great improvements in the products of the optician's skill which have taken place have had their origin mainly in Germany.

This brings me to our last example of the manner in which science and practice may combine to produce effects unattainable by either singly. But before dealing with this I would mention one great advantage which, until a few years ago, the English optician possessed in a special degree, an advantage to which much of the progress of our English lenses is undoubtedly due. The story of Gunand's invention of optical glass is deeply interesting. A poor carpenter, and later a watch-case maker, of Brenetz, in canton Neuchatel, he was born in 1740, and became at an early age interested in telescopes. Prompted by the desire to possess a pair of spectacles, he undertook to make the glass for the lenses. A little later, through M. Droz, a gentleman of the neighbourhood, he was allowed to examine one of Dolland's achromatic lenses, and learnt of the difficulty of obtaining the flint glass required. This he determined to make, and years of penury and unremitting toil followed, until at last he succeeded in casting discs sufficiently homogeneous to be used for optical work.

Fraunhofer persuaded him to migrate to Munich, but the venture was not a success. He returned to Switzerland, and again started glass making. After his death his son told the secret of the art to George Boutemps, a Frenchman, who some years later was brought to England by Messrs. Chance, and helped them to establish the optical glass works which for so long were practically the sole source of the supply of raw material for the optician.

Our catalogue to-day bears witness to the progress in glass manufacture that has taken place since Boutemps's time, and it is right to recognise the influence that progress has had on opticians' work.

But to return to our main subject. An optical convention in 1905 would be incomplete without some reference to the work of that master optician who a few months ago was taken from us, the more so since the work of Ernst Abbe affords perhaps the most striking illustration of the effects of the reasoned combination of theory and practice. A comparison of the statistics of the optical trade of Germany now and twenty years ago will suffice to prove this.

The story of the growth of the Jena industry has been told frequently, still I will repeat it in barest outline. Abbe, then a young man, had settled at Jena as a privat docent in 1863, and soon after Carl Zeiss, who then made microscopes of the ordinary class, applied to him for help in the development of the instrument. Abbe's task was a hard one; the theory of the microscope was at that date only partially understood, the corrections to the lenses were made by a rough trial and error method, and the results were doubtful. The first step was to solve a mathematical problem of no small difficulty, to trace the paths

of the pencil through the object glass. Abbe soon realised the defects of the ordinary theory. He found it necessary to apply the principles of the wave theory, the teaching of Young and Fresnel, to the problem, and was led in 1870 to the theory of microscopic vision which bears his name. His work was the direct outcome of that of Fresnel.

He soon realised that it followed from the mathematical theory that with the glass then at the optician's disposal no great improvement in the microscope object glass could be expected. Certain relations between the dispersion and refraction in the various lenses were requisite to secure achromatism, and no glass having these relations existed. An inspection of the instruments in our loan exhibition at South Kensington in 1876 confirmed this view, and he published it in a report in 1878 on the results of the exhibition:—"The future of the Microscope as regards its future improvement in its dioptric qualities seems to be chiefly in the hands of the glass maker."

The investigations of Petzval and of von Seidel led to a similar result with regard to photographic lenses. Von Seidel's work dates back to 1856–7, but his main paper was not written until 1880, after the date of Abbe's report, and was not published in full until 1898.

It follows from these investigations that with the glass then on the market it was impossible to make the field of a photographic lens at once flat and achromatic.

Thus the theoretical work indicated a bar to future progress which could only be removed by the manufacture of new glasses having certain definite properties. It is fitting to say that at an earlier date this fact had been recognised by our countrymen Mr. Vernon Harcourt and Prof. Stokes, who for some eight years previous to 1870 had endeavoured, but with scant success, to make the glass required.

Abbe was more fortunate; his report fell into the hands of Dr. Otto Schott, a glass maker of Witten, in Westphalia, who realised its importance. In 1881 Schott communicated with Abbe, and the next year he removed to Jena, and the firm of Schott and Partners was born.

In the first catalogue of the Jena Glass Works they write:—"The industrial undertaking here first brought into public notice and which has arisen out of a scientific investigation into the dependence between the optical properties and the chemical composition of solid amorphous fluxes was undertaken by the undersigned (Schott and Abbe) in order to discover the chemicophysical foundations of the behaviour of optical glass." The inquiry was aided by large grants from the Prussian Minister of Education. The practical result is seen in the catalogue of the Jena firm and the enormous export of German optical goods.

Nor is this all, for in virtue of the distribution of profits settled by the scheme of the Carl Zeiss Stifting, drawn up by Abbe some years ago and ratified by the Bavarian Government, the University of Jena alone has received a sum approaching 100,000*l*. Abbe's work at Jena is perhaps the most striking illustration of the way in which progress depends on the cooperation of science and experience. One could give statistics to illustrate the truth of this and the important effect it has had on German trade and prosperity. They are hardly necessary; the facts are patent, and their cause well known to all who care to inquire. We can progress too if we follow the path laid down for us of old by Newton, Young, Herschel, Airy, and the others of whom I have spoken.

EXHIBITION OF OPTICAL AND SCIENTIFIC INSTRUMENTS.

The exhibition of optical and scientific instruments which is being held during the present week at the Northampton Institute, Clerkenwell, E.C., in connection with the optical convention, presents many features of interest, and all who have had any experience in the use of an optical instrument, from the wearing of a pair of spectacles to the handling of an accurate spectrometer, will find something to repay the trouble of a visit to Clerkenwell, still the centre of the optical industry. While the number of actual novelties offered is not, perhaps, very large, there are few classes of instruments unrepresented, and though the names of certain important firms are conspicuously absent from the list of exhibitors, the exhibition as a whole may be taken as well representative of the activities of the British manufacturers of optical and other scientific instruments.

In the main of an optical character, the scope of the exhibition has been extended to cover such other scientific instruments as are usually manufactured by optical instrument makers. Meteorological instruments and thermometers, mathematical and drawing instruments and calculating machines, and laboratory apparatus generally, are thus included. Electrical measuring instruments, however, are not shown. It is for many reasons to be regretted that the exhibition has been confined to the work of British makers; a foreign section would have had much interest for the ordinary visitor, and would have been of great educational value both to the British manufacturer and his competitors; we understand, however, that the limitation was dictated by considerations as to space, and the necessity of restricting the magnitude of a somewhat novel undertaking.

In the catalogue which has been prepared in connection with the exhibition, the convention committee is to be congratulated on having produced a volume which should be of considerable value as well to the user of scientific instruments as to the firms whose instruments are there described. The volume is not confined to apparatus actually exhibited; the aim has been to provide a convenient work of reference generally descriptive of the productions of British firms, and in which particulars as to the types offered by different makers of any special instrument may be readily found. To this end the instruments have been arranged in classes, which are in many cases further subdivided, and in addition to a table of contents, an alphabetical list of exhibitors, with general information as to their manufactures, and an index of instruments have been provided. A short introduction to each class furnishes some particulars as to the instruments included thereunder, with notes as to recent advances in the mode of construction.

In class i., tools and materials, the most interesting exhibit is that of Messrs. Chance Bros., which includes some varieties of optical glass only quite recently produced by the firm, and not previously shown. Some special opal glass of low coefficient of expansion for speculum discs is also exhibited. Messrs. Jas. Powell and Sons, of the Whitefriars Glass Works, show specimens of glass for thermometers and other purposes. Tools for lens grinding, and exhibits illustrating processes of manufacture, are shown by Messrs. Geo. Culver and other firms.

Class ii., simple elements and instruments, includes some accurate glass work by Messrs. A. Hilger, while Lord Blythswood shows specimens of his diffraction gratings ruled on speculum metal, 14,400 lines to the inch, up to a length of 6 inches. Replicas of Rowland gratings, with spectroscopes of various forms in which they are employed, are shown by Mr. T. Thorp, of Manchester.

Class iii., astronomical instruments, and class iv., nautical instruments, are by no means representative of the best English work, and it is to be regretted that the catalogue is here so meagre.

In class v., surveying instruments, on the other hand, few firms of importance are omitted, and some excellent work is shown. In particular may be mentioned the Wells theodolite of Messrs. Elliott Bros., which embodies several novel features; Messrs. Joseph Casartelli and Son, of Manchester, also show instruments of somewhat special pattern. Messrs. W. F. Stanley, J. J. Hicks, and E. R. Watts and Son are well represented. The chief characteristics of the more modern instruments are the use of larger and more powerful telescopes, and the increased accuracy of graduation.

Class vi. is devoted to range finders and heliographs, and the exhibits of most interest are the naval and field range finders of Messrs. Barr and Stroud, and the stereoscopic range finder of Prof. Geo. Forbes. Messrs. Ross, Ltd., show specimens of their new variable power gun sighting telescopes, in which by a simple device the power can be altered while the image remains always in focus on the cross wires.

Class vii. includes meteorological instruments and thermometers, and most of the well known makers have sent exhibits. In class viii., spectacles and eyeglasses, the exhibits are also sufficiently representative of the best English

work. An historical collection of no little interest is shown by Mr. M. W. Dunscombe, of Bristol.

In class ix., small telescopes and binoculars, are exhibited various patterns of prism binoculars by Messrs. Aitchison, Dallmeyer, Ross, Ltd., &c. Messrs. Aitchison show also a field glass of novel type with a body machined from a solid casting, focusing being effected by moving each object glass in its own tube.

In class x., microscopes and accessories, the catalogue furnishes a very complete account of the English microscope as produced by the best makers, including binocular microscopes and various forms of instrument for special purposes. Photomicrographic cameras are shown by Messrs. Beck, and Ross, Ltd. Information of interest with regard to different types of photographic lenses is given in class xi., though too much space is perhaps devoted in the catalogue to illustrations of camera bodies.

In the careful classification and selection of instruments to illustrate the various types, class xii., optical projection apparatus, appears to us to be the most successful in the catalogue. The class includes an exhibit by Messrs. Chance Bros. of a complete lighthouse optical apparatus of the fourth order. Other exhibits of interest are Mr. R. W. Paul's projector lamps, the triple rotating lantern of Messrs. Newton, and animatographs by Messrs. Paul, the Prestwich Manufacturing Co., and J. Wrench and Son.

In class xiii., apparatus for optical measurement, some new optical benches are shown by Messrs. Aitchison and Beck, and there are interesting exhibits from the Cambridge Scientific Instrument Co. and Messrs. Hilger. A half-shadow polarimeter is shown by Prof. Poynting, the half-shadow field being produced by the tilting of two glass plates forming a V between the polariser and analyser.

Under photometric apparatus the Ediswan Co. show specimens of Prof. Fleming's large bulb standard lamps, and various forms of photometer are exhibited by Messrs. Alex. Wright. Class xv. is devoted to ophthalmic apparatus, and includes a novel form of ophthalmoscope of British design and construction. The Cambridge Scientific Instrument Co. and Messrs. Griffin show laboratory apparatus under class xvi. Under class xvii., mathematical and drawing instruments, some new forms of slide rule are shown, including one with additional slides by Messrs. Davis, of Derby, and an optical slide rule with reciprocal division for determination of conjugate foci, &c., by Mr. A. Salomon, of Huddersfield. An arithmometer of English make is exhibited by Mr. S. Tate, and an adding machine by the Burroughs Adding Machine Co.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Among the twelve distinguished men who will receive honorary degrees on June 14 only two are connected with scientific work. These are Commander R. F. Scott, R.N., of the *Discovery*, and Colonel Sir Francis E. Younghusband, K.C.I.E. The latter has been appointed Rede lecturer, and has chosen as his subject "Our True Relationship with India." The lecture will be delivered in the Senate at 11.30 a.m. on Saturday, June 10.

Mr. L. A. Borradaile, of Selwyn College, who is well known for his researches on the crustacea, has been appointed assistant secretary for lectures to the local examinations and lecture syndicate.

A university lectureship in mathematics will shortly be vacant owing to the resignation of Mr. G. B. Mathews, F.R.S., of St. John's College.

The special board for biology and geology has nominated Mr. J. J. Lister, Fellow of St. John's College, to occupy the university table at the laboratory of the Marine Biological Association at Plymouth for one month during the present year.

In spite of the efforts of the master of Pembroke, Prof. Ridgway and others to bring the work of the studies and examination syndicate to an end, the Senate decided by 112 votes to 99 that its deliberations should be continued. It seems evident that a majority of residents is in favour of some change.

The syndicate entrusted with the building of the new medical schools has exceeded the sum granted by Grace of the Senate by 2571*l*. 15*s*. 6*d*. It is now asking for authority to pay this amount, and for 020*l*. for the completion and fitting of the Humphry Museum, and 380*l*. for extra fittings and furniture in the departments of surgery, midwifery, medicine, pharmacology, and pathology.

THE *Pioneer Mail* states that a grant of 10,000 rupees has been made to the Victoria Diamond Jubilee Technical Institute of Lahore for buildings and appliances. A permanent grant of 100 rupees a month has also been made, and the assistance thus given will enable the governors to complete the equipment for the teaching of practical and applied chemistry.

AT a meeting of the School Nature-Study Union held at the College of Preceptors on Friday, a paper was read on the training of teachers for nature-study by Miss R. Lulham. In it the necessity for a proper ground work was brought out, and during the discussion which followed a resolution was passed urging upon the London County Council the need of providing classes for those who have to teach nature-study, and suggesting that a wild garden for their benefit should be established in at least one of the London parks, in which the botanic gardens arranged for the students of systematic botany have already proved so useful.

WE have received the first number of the *University Review*, which is published by Messrs. Sherratt and Hughes at 6*d*. net. Dr. Bryce contributes an introductory note on the university movement, and among other articles dealing with many aspects of higher education may be mentioned one by Prof. Arthur Schuster, F.R.S., on "Universities and Examinations," and another by Sir Oliver Lodge, F.R.S., on "Questions for Discussion." Prof. Schuster formulates briefly what the aims of an ideal university should be, and proceeds to divide its work into two parts. These are the acquisition of knowledge and the power of applying it. The second part of the work of the university is the higher, and is what is required for success in life. Prof. Schuster says that it can be taught, and therefore should be taught, in the university, but that this power of applying knowledge cannot be tested satisfactorily by examination. He then considers exhaustively the function of examinations, and shows what they are capable of doing and the qualities they are incompetent to gauge. He concludes by remarking that when a student "has shown that he deserves a degree, it is right and proper that an opportunity shall be given him to develop his special powers and to distinguish himself." Prof. Schuster makes a proposal to secure this by giving a year which is absolutely at the student's disposal to be used under the guidance of his teachers as he thinks fit. Sir Oliver Lodge discusses the possibility of introducing a change in the "time of year when examinations should be held:—whether candidates should be examined directly lectures cease, and before Session ends; or whether they should be given time for revision and digestion, and perhaps oblivion, and be examined just before a new Session commences." The review also supplies full information of current events in British and foreign universities.

SOCIETIES AND ACADEMIES.

LONDON.

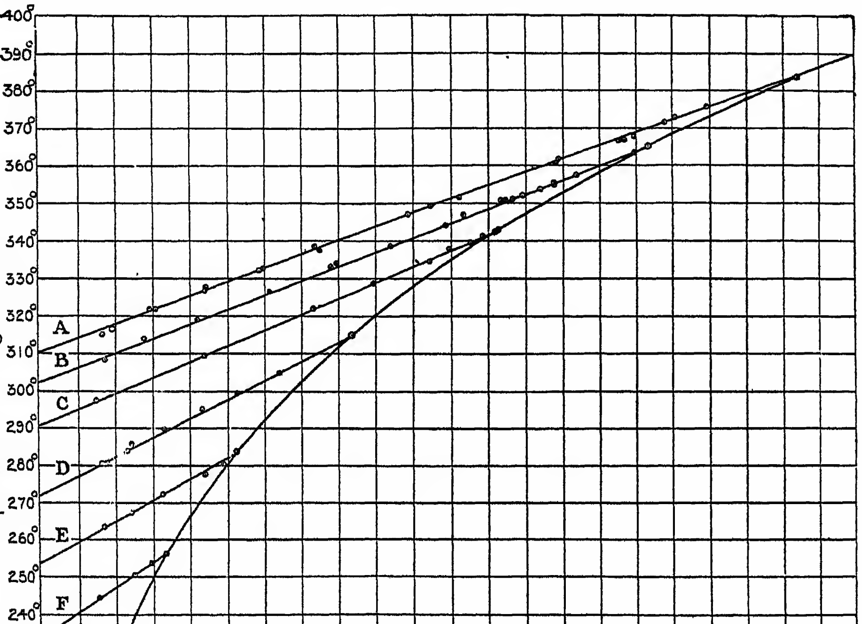
Royal Society, March 30.—"The Determination of the Specific Heat of Superheated Steam by Throttling and other Experiments." By A. H. **Peake**. Communicated by Prof. Ewing, F.R.S.

This paper is an account of original investigations undertaken to determine the specific heat of superheated steam. Two methods have been followed:—(1) the throttling or wire-drawing of steam to obtain the law connecting the variation of temperature with pressure, for constant total heat; (2) the direct heating of a current of steam by electrical means.

An account of an investigation on the same lines as method (1), by Mr. J. H. Grindley, was published in the *Philosophical Transactions of the Royal Society*, A, vol.

cxciv. pp. 1 to 36. The results here given differ from those obtained by Mr. Grindley in one important particular. Mr. Grindley came to the conclusion that steam taken from a separator contained a definite proportion of suspended moisture, because when he caused such steam to expand through an orifice to a slightly reduced pressure the steam did not become superheated, but its temperature fell to that corresponding to saturated steam at the new pressure. In the research here described, however, it was found that steam taken from a separator and reduced in pressure in the slightest degree by wire-drawing became superheated. This result was only obtained after a considerable amount of experimental work had been done, and a number of improvements made in the apparatus as first constructed.

The experimental results obtained in the throttling experiments are represented in the accompanying figure. The curves A, B, C, D, E, and F show the connection between the temperature and pressure of superheated steam for constant total heat. The method of obtaining



each of these curves was as follows:—The pressure of steam in the separator was maintained constant at the point where the constant total heat curve meets the curve which connects the pressure with temperature for saturated steam; the pressure on the low-pressure side of the orifice could be regulated by means of a wheel valve, which allowed the steam to escape at any desired rate. This lower pressure was adjusted to various values, and the temperatures corresponding were observed when the conditions had become steady. By plotting these results points were obtained which enabled the curve to be drawn.

The total heat corresponding to each of the curves was obtained from Regnault's tables for saturated steam, and the specific heat at constant pressure calculated for various pressures. The specific heat as thus calculated was found to increase rapidly with increase of temperature from 0·43 at 230° F. to 1·0 at 350° F. This apparent increase in the specific heat led the author to suspect the accuracy of Regnault's tables, and caused him to turn to the direct heating method, with the result that he is now convinced that Regnault's tables are not sufficiently accurate for the purposes of these calculations, and that a great degree of accuracy would be necessary before such was the case.

In method (2) the rise in temperature was observed in steam flowing at a measured rate, due to the heat imparted by an electric current, and the specific heat calculated from the formula

$$K_p = \frac{\text{electrical input in watts} \times 0{\cdot}236}{\text{grams of steam passing per sec.} \times \text{temp. rise}\ {}^\circ\ \text{C.}}$$

The connection between grams of steam passing per minute and the input of electrical energy in watts for a definite rise in temperature was obtained for rates of flow differing over a considerable range; the points thus obtained were plotted on squared paper, and were found to lie on a straight line which did not pass through the origin, but cut the watts ordinate at a height corresponding to the radiation loss expressed in watts.

The difficulty experienced in keeping all the conditions constant during the long time necessary for a complete set of points was always considerable. Numerous experiments were carried out, but the results varied too much amongst themselves to enable conclusions to be drawn as to the manner in which the specific heat may vary with pressure or temperature, except that any such variation must be small, and by no means of the order indicated by the results of the throttling experiments based on Regnault's tables.

The mean value of the specific heat of superheated steam at constant pressure obtained from the most satisfactory experiments was 0·46.

May 11.—"A Study of the Process of Nitrification with Reference to the Purification of Sewage." By Dr. Harriette **Chick**. Communicated by Prof. Marshall Ward, F.R.S.

The process of nitrification during sewage purification was studied by means of small experimental filters erected in the institutes of hygiene in Vienna and Munich.

The oxidation of sewage passing through the filters was investigated during the maturing period, and also when the filters were mature, a special study being made, chemically, of the oxidation of the nitrogen from the ammoniacal form to that of nitrites and nitrates, and of the distribution of these processes both in time and space.

Nitrification was traced to the activity of two sets of organisms, the first of which oxidised ammonia to nitrous acid, and the second completed the oxidation to nitric acid. These bacteria were found to differ only very slightly from those isolated from the soil by Winogradsky, thus confirming the recent results of Schultz-Schultzenstein. The activity in sewage filters of these organisms, which are very sensitive to the presence of organic matter, requires explanation, and various explanations are considered, based upon experimental foundation.

The theory of previous physical absorption of ammonia upon the surface of the filtering material and subsequent nitrification was found to be unsupported by experiment; nitrification is rather to be considered as a very rapid biological process, requiring only the time taken by the sewage to trickle through the filter.

Linnean Society, May 4.—Prof. W. A. Herdman, F.R.S., president, in the chair.—The botany of Gough Island, part i., phanerogams and ferns: R. N. **Rudmose-Brown.** Gough Island, or Diego Alvarez, lies in the mid South Atlantic, lat. 40° 20′ S., long. 9° 56′ 30″ W., and may be regarded as the most outlying member of the Tristan da Cunha group, a small island between seven and eight miles long, and half as wide, rising to a height of 4000 feet. It has been occasionally visited, but never permanently inhabited. The chief features of the vegetation are the tree *Phylica nitida* and the tree-fern *Lomaria Boryana*. Four of the seventeen species of phanerogams are almost certainly introduced, while two are new to science, a species of Cotula and an Asplenium. The Scottish Antarctic Expedition lay off the island for three days in April, 1904, but owing to high sea landing was only practicable on one day, when the materials for the present paper were collected.—The study of vegetation: its present condition and probable development: Prof. A. G. **Tansley.** The word œcology, introduced by Prof. Haeckel, means the study of the vital relations of organisms to their environment, and by Prof. E. Ray Lankester was termed bionomics. Restricting his remarks to a special branch of the subject, the author proceeded to consider the plant-association as the unit, the great fact being the association of plants under definite conditions of environment. Instances were given of sets of plants found in meadows, woods, cultivated fields, moors, and dunes.—Schizopoda captured in the Bay of Biscay during a cruise of H.M.S. *Research*: E. W. L. **Holt** and W. M. **Tattersall,** with an appendix dealing with the distribution statistically by Dr. G. H. **Fowler.** The paper forms part v. of the series on Biscayan plankton. Ten genera and eleven species were described; of these one species is new to science, and one, previously known from a single example, is represented by eight specimens. All the commoner forms are epiplanktonic, but of these some are represented by scattered specimens from greater depths. *Euphausia pellucida,* essentially epiplanktonic, with a centre of distribution about 50–75 fathoms, seems to show a marked vertical oscillation, rising by night and sinking by day: it was plentiful in bright moonlight; by day scattered specimens occurred between 250 and 100 fathoms. *Meganyctiphanes norvegica,* caught in small numbers and on few occasions, was only captured by night, never by day at any depth whatsoever. Messrs. Holt and Tattersall suggest that this species is sufficiently sharp-sighted to see and avoid a net by daylight, even at a depth of 100 fathoms. *Nematoscelis megalops,* with the same distribution as *Euphausia pellucida,* showed a less clearly marked oscillation.

Anthropological Institute, May 9.—Dr. A. C. Haddon, F.R.S., vice-president, in the chair.—Some tribes of the Uganda Protectorate: Lieut.-Colonel C. **Delmé-Radcliffe.** The author described the customs and habits of the natives with whom he came in contact, including the Kavirondo and other tribes on the Victoria Nyanza, and the Acholi in the Nile Province. The paper was illustrated by numerous lantern slides, illustrating the peoples, animals, and scenery, and by a large and interesting collection of ethnographical specimens from the Protectorate.

Challenger Society, May 10.—Prof. d'A. W. Thompson, C.B., in the chair.—A new species of Tuscarusa from the North Atlantic: Dr. **Wolfenden.**—Observations on the temperature and salinity of the water of the North Atlantic, made during two cruises of Dr. Wolfenden's yacht *Silver Belle* during the summers of 1903 and 1904: Dr. H. N. **Dickson.** In 1900–2 much valuable work had been done by Dr. Wolfenden in the Færöe Channel, but as this area lay within the field of the International Council for the Study of the Sea, he worked in 1903 farther out in the Atlantic, to the west of Ireland, and at the entrance to the Færöe Channel south of the Wyville-Thomson Ridge, the observations connecting directly with those of the International Council in the Channel itself and in the Norwegian Sea during the August cruises. The work in 1904 was more directly concerned with the general oceanic movements of Atlantic waters; a line of soundings was run from the south-west of Ireland to the Azores, thence into the Mediterranean through the Straits of Gibraltar, and thence to the English Channel. Dr. Dickson illustrated the observations by diagrams of temperature and salinity along the sections, and discussed the considerable light thrown on the behaviour of the easterly drift on reaching the shores of Europe, the exchange of waters between the Atlantic and the Mediterranean, the volume of current in the straits, and the extension in the Atlantic of Mediterranean water of high temperature and salinity.

Geological Society, May 10.—Mr. R. S. Herries, vice-president, in the chair.—The geology of Dunedin (New Zealand): Dr. P. **Marshall.** A detailed account of the petrography of the district was given. The age of the oldest rocks seen, mica-schists, is not definitely known. They are followed by Tertiary sandstones and limestones. Fine, plant-bearing shales succeed unconformably, and upon these, again, rests a light scoria-bed. The igneous rocks next described cover them. These rocks include an ill-exposed, gold-bearing syenite, a diorite, lavas, rhomb-porphyry, tinguaite, hypabyssal trachydolerite, a teschenite-dyke, and trachyte. Trachytoid phonolites occur as inter-bedded sheets. The andesites are characterised by hornblende and augite. Dolerites of two principal types occur in dykes, one type being the commonest of all the rocks in the area. A considerable series of chemical analyses follows, showing that the silica-percentage varies from 66 in the Portobello trachyte to 44·84 in one of the dolerites. The relative ages of the volcanic rocks are worked out so far as possible.—The Carboniferous limestone of the Weston-super-Mare district: T. F. **Sibly.** The Carboniferous limestone of the Weston-Worle ridge includes part of the Syringothyris-zone (C), extending from the "laminosa-dolomites" upwards, and part of the Seminula-zone (S). While the dip of the rocks of the ridge is towards the south, a reversed fault throws the Syringothyris-beds on the south against the Seminula-beds to the north, and the latter rocks are over-folded on the north side of the fault. The lower part resembles the equivalent part of the Clevedon sequence, and indicates shallow-water conditions; the upper part of C resembles the corresponding part of the Burrington section, and indicates the predominance of a Mendip-facies. The Woodspring ridge shows a sequence exactly similar to that of Clevedon. There were two periods of volcanic activity, one of which occurred at the close of Zaphrentis-time and the other early in Syringothyris-time.

Physical Society, May 12.—Dr. C. Chree, F.R.S., vice-president, in the chair.—A simple method of determining the radiation constant, suitable for a laboratory experiment: Dr. A. D. **Denning.** The apparatus consists of a hemispherical copper cap to the outside of which is affixed a jacket through which steam or water can be passed. The receiving surface consists of a silver plate, and the rate of rise of temperature of the plate is measured by means of a silver-constantan thermo-junction. When performing the experiment, a non-conducting pad is placed between the hemisphere and the silver disc until the temperature of the jacket is uniform. Then the pad is slid out, and the deflections of the galvanometer in the thermo-junction circuit are noted every few seconds. By plotting these deflections on a curve the initial slope of the curve, *i.e.* the initial rate of rise of temperature of the silver disc, is obtained; and from this, knowing the constants of the disc, &c., the radiation constant can be calculated.—A bolometer for the absolute measurement of radiation: Prof. H. L. **Callendar.** It is now generally agreed that the electric compensation method, in which the heat received by radiation on a metallic strip is determined by measuring the electric current required to produce the same rise of temperature in the strip, is the most satisfactory and accurate method for absolute measurement. In the practical application of the bolometric method for the absolute measurements of solar radiation, the author has introduced certain modifications suggested by experience in platinum thermometry, with the object of securing (1) temperature compensation, so that the zero remains constant in spite of changes in the surrounding temperature; (2) conduction compensation, so that loss of heat by conduction at the ends of the strips may not affect the readings; (3) accurate measurement of the area of radiation absorbed. Comparisons have been made between

the bolometer, in which the platinum strips are directly exposed to radiation, and one of the author's ordinary sunshine receivers enclosed in a glass bulb, in order to determine the effect, if any, of the glass bulb in selective absorption. The values of the reduction constant obtained for the glass receiver showed no certain variation over a wide range of quality of radiation, from sunshine or arc-light down to a dull red heat. This result is probably to be attributed to a self-compensating action of the glass bulb, which radiates to the enclosed coils precisely those rays which it absorbs.—Results of experiments carried out at Crompton's works at Chelmsford, by Mr. C. H. Wright, on the possibility of using the resistance of a conductor heated by an alternating electric current as a measure of the current: W. H. **Price.**

Zoological Society, May 16.—Mr. G. A. Boulenger, F.R.S., vice-president, in the chair.—Examples of a new golden mole obtained in connection with Mr. C. D. Rudd's exploration of South Africa: O. **Thomas.** It is proposed to call the mole *Amblysomus corriae*, sp. n.—Microscopic slides of *Lankesterella tritonis*, a hæmogregarine parasitic in the blood-corpuscles of a newt, *Triton cristatus*: H. B. **Fantham.** This parasite was recently found by Mr. A. S. Hirst and the exhibitor, and their observations had since been independently confirmed by Dr. A. C. Stevenson.—A contribution to the knowledge of the encephalic arterial system in Sauropsida: F. E. **Beddard.**—Criticisms of the Hon. Walter Rothschild's proposed classification of the anthropoid apes: Sir H. H. **Johnston.** The author was disposed to agree with Mr. Rothschild's classification of the African apes, but suggested that the proper transcription of the native name for the bald chimpanzee should be *nkulunkamba* instead of (as Du Chaillu wrote it) *kooloo-kamba*. He, however, could not agree with Mr. Rothschild's proposed change of the generic name of the orang from Simia to Pongo, and although considering him right in applying the former name, at present used for the orang, to the chimpanzees, he was of opinion that either Satyrus or Pithecus was a far preferable name to Pongo for the orang. He concluded the paper with a list of words used in several African languages for the name of the chimpanzee, and with a *précis* of the history of European knowledge of the anthropoid apes down to the eighteenth century.—Some species of bats of the genus Rhinolophus: K. **Andersen.** The author showed the progressive evolution from the Austro-Malayan *R. simplex* (allied to *megaphyllus*), through a long series of Oriental forms, to the W. Palæarctic *R. ferrum-equinum*, and a similar chain from the Oriental *R. lepidus* (allied to *minor*) to the W. Palæarctic *R. blasii* and *R. euryale*. *R. hipposiderus* was traced back to the Oriental *R. minor*. A slight difference between the British colony of *R. hipposiderus* and the central European form of the same species was pointed out. All the Ethiopian species of Rhinolophus were shown to be of Oriental origin.—Results of observations on the stridulating-organs and descriptions of five new species (two of which were referred to new genera) of the hemipterous family Halyinæ: Dr. E. **Bergroth.**—On the anatomy of limicoline birds, with special reference to the correlation of modifications: Dr. P. C. **Mitchell.** The paper dealt with the anatomy, chiefly muscular, of Charadriidæ, Chionididæ, Glareolidæ, Thinocoridæ, Œdicnemidæ, and Parridæ.—Results of observations made upon a female specimen of the Hainan gibbon (*Hylobates hainanus*), now living in the society's gardens: R. I. **Pocock.**

PARIS.

Academy of Sciences, May 22.—M. Troost in the chair.—New experiments in experimental parthenogenesis in Asterias: Yves **Delage.** Additional proof is given of the fact that it is not an increase in the osmotic pressure alone which determines parthenogenesis, several of the reagents employed, manganese chloride, sodium phosphate, &c., acting as well, if not better, when the total concentration of the mixture is lower than that of sea water. Attention is directed to the marked action of solutions of manganese chloride, a salt which is not present in sea water.—Magnetic hysteresis produced by an oscillating field superposed on a constant field. Comparison between theory and experiment: P. **Duhem.** The author compares the results obtained by him in a theoretical study recently published with some experimental results of M. Maurain, and shows that his theoretical conclusions are completely confirmed.—On the voyage of the *Princesse Alice*: the **Prince of Monaco.** A sketch is given of the work attempted in oceanography, bacteriology, chemical biology, zoology, and the meteorological exploration of the upper atmosphere by means of kites.—On a condition of convergence of Fourier's series: Henri **Lebesgue.**—On minimal curves: E. **Vessiot.**—On the compressibility of different gases below atmospheric pressure and the determination of their molecular weights: Adrien **Jaquerod** and Otto **Scheuer.** The compressibility of several gases has been measured at 0° C. for pressures between 400 mm. and 800 mm. of mercury, and for ammonia and sulphur dioxide for pressures between 200 mm. and 400 mm. From the measurements the coefficient of deviation from Boyle's law has been determined, and this has been applied to the formula of D. Berthelot for the limiting density of gases and the estimation of their molecular weight. The molecular weights calculated agree with those obtained by the best analytical methods with the exception of nitrogen compounds, for which an atomic weight of 14·01 must be assumed.—The atomic weight of nitrogen deduced from the ratio of the densities of nitrogen and oxygen: Philippe A. **Guye.** From a consideration of the whole of the experimental data available, the mean value $N = 14{\cdot}009$ must be regarded as the most probable value for the atomic weight.—On the fusibility of the mixtures of antimony sulphide formed with cuprous sulphide and mercuric sulphide: H. **Pélabon.**—The equilibrium between acetone and hydroxylamine hydrochloride: Philippe **Landrieu.** This equilibrium has been previously studied by means of the acid set free during the reaction, but owing to the rapidity with which the equilibrium is displaced this method is not trustworthy. In the present paper the reaction is followed by calorimetric studies.—Physicochemical researches on hæmolysis: Mlle. P. **Cernovodeanu** and Victor **Henri.**—The action of the metal ammoniums on the polyatomic alcohols: E. **Chablay.** The alcohol is dissolved in liquid ammonia and is then acted on by the solution of the alkali metal, sodium or potassium, also dissolved in ammonia, and the result of the reaction washed several times with liquid ammonia at −40° C. In this way one of the hydroxylic hydrogen atoms of the alcohol is replaced by potassium (or sodium), the alcohols studied being mannite, erythrite, and glycerol.—On benzhydroxamic and dibenzhydroxamic acids: R. **Marquis.**—A new method of preparing mesoxalic esters: their condensation with cyanacetic esters: Ch. **Schmitt.** The corresponding malonic esters are treated with nitrous fumes, descriptions being given of the preparation of the methyl and ethyl esters. These condense with cyanacetic esters in the presence of piperidine, one or two molecules of the cyanacetate entering into the reaction according to the experimental conditions.—The basicity of pyranic oxygen. Double halogen salts of some metals and dinaphthopyryl: R. **Fosse** and L. **Lesage.** The group dinaphthopyryl,

$$-\mathrm{CH}\begin{matrix}\diagup \mathrm{C_{10}H_6} \diagdown \\ \diagdown \mathrm{C_{10}H_6} \diagup\end{matrix}\mathrm{O},$$

possesses basic properties attributable to tetrabasic oxygen strikingly analogous to an alkaline metal, and the present communication gives details of the preparation of several double salts of this radical.—On some circumstances influencing the physical state of starch: J. **Wolff** and A. **Fernbach.**—Researches on animal lactase: Ch. **Porcher.** It is shown that ether saturated with water is capable of extracting from the intestines of certain animals considerable quantities of lactase.—Contribution to the study of histological staining substances: G. **Halphen** and André **Riche.** The albuminoid substances in animal tissues preserved in formol solutions are profoundly altered, and the methods of staining to be employed require considerable modifications.—On some minerals of Djebel-Ressas (Tunis): L. **Jecker.**—Variation in the histological characters of leaves in the galls of *Juniperus Oxycedrus* from the Midi and Algeria: C. **Houard.**—On the biology of *Melampyrum pratense*: L. **Gautier.**—On the transformations of the nitrogenous materials in seeds in the course of maturation: G. **André.**—Observations on the fibrous intersections of

the polygastric muscles: J. **Chaine.**—The respiratory curve in the newly-born: L. **Vallois** and C. **Fleig.**—On the food value of different kinds of bread: Pierre **Fauvel.**

CALCUTTA.

Asiatic Society of Bengal, May 3.—Contributions to Oriental herpetology, iii., notes on the Oriental lizards in the Indian Museum (part ii.), Lacertidæ, Scincidæ, and Dibamidæ: Dr. N. **Annandale.** Three new Indian skinks are described, and four imperfectly diagnosed species re-described, while one, *Lygosoma pulchellum,* is added to the fauna of Burma. Notes on other examples of the family and of the Lacertidæ are given, based on the late Dr. J. Anderson's collection from N.W. Asia and the late Prof. J. Wood-Mason's from Sinkip Island and Malaya, as well as the extensive Indian, Burmese, and Persian collections in the museum. A revised list of the species recorded from India, Burma, and Ceylon is appended, with their distribution within these limits.—Materials for a flora of the Malayan Peninsula, No. 16: Sir G. **King** and J. S. **Gamble.** The present contribution to these materials contains the account of the genus Psychotria required to conclude the joint account by the authors of the natural order Rubiaceæ commenced in part xiv. and continued in part xv. of this series. This account of Psychotria comprises descriptions of 26 completely represented and 3 imperfectly known species; of these, 11 species are new to science. In addition, this fasciculus contains accounts, for which the authors are jointly responsible, of several natural orders.

DIARY OF SOCIETIES.

THURSDAY, JUNE 1.

ROYAL INSTITUTION, at 5.—Electro-magnetic Waves: Prof. J. A. Fleming, F.R.S

INSTITUTION OF MINING ENGINEERS (in the Rooms of the Geological Society), at 11 A.M.—The Firing of Babcock Boilers with Coke-oven Gases: T. Y. Greener.—Compound Winding-engine at Lumpsey Mine: M. R. Kirby.—Note Supplementary to a Paper on the Electric Driving of Winding-gears: F. Hird.—Electric Winding engines at the Exhibition of the North of France, Arras, Pas-de-Calais: Ed. Lozé.—The Education of Mining Engineers in the United States: Prof. Howard Eckfeldt.—An Outline of Mining Education in New Zealand: Prof. James Park.—Goaf-blasts in Mines in the Giridih Coal-field, Bengal, India: Thomas Adamson.

LINNEAN SOCIETY, at 8.

CHEMICAL SOCIETY, at 8.—(1) The Constituents of the Seeds of *Hydnocarpus Wightiana* and *Hydnocarpus Anthelmintica.* Isolation of a Homologue of Chaulmoogric Acid.—(2) The Constituents of the Seeds of *Gynocardia Odorata*: F. B. Power and M. Barrowcliff.—The Relation of Ammonium to the Alkali Metals. A Study of Ammonium Magnesium and Ammonium Zinc Sulphates and Selenates: A. E. H. Tutton.—Camphorylazoimide: M. O. Forster and H. E. Fierz.—Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds. Part III. Azo-derivatives of the Symmetrically Disubstituted Primary Metadiamines: G. T. Morgan and W. O. Wootton.—Diazo-derivatives of Mono-acylated Aromatic Para-diamines: G. T. Morgan and Miss F. M. G. Micklethwait.—The Significance of Optical Properties as Connoting Structure; Camphorquinone-hydrazones-oximes; a Contribution to the Chemistry of Nitrogen: H. E. Armstrong and W. Robertson.—Solubility as a Measure of the Change undergone by Isodynamic Hydrazones. (1) Camphorquinonephenylhydrazone. (2) Acetaldehydephenylhydrazone: W. Robertson.—The Design of Gas-regulators for Thermostats: T. M. Lowry.—The Constitution of Barbaloin. Part I.: H. A. D. Jowett and C. E. Potter.—Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds. Part IV. 5-Bromo-*as*(4)-dimethyl-2: 4-diamine-toluene: G. T. Morgan and A. Clayton.—The Action of Hypobromous Acid on Piperazine: F. D. Chattaway and W. H. Lewis.—The Action of Magnesium Methyl Iodide on Pinene Nitrosochloride: W. A. Tilden and J. A. Stokes.—Racemisation Phenomena during the Hydrolysis of Optically Active Menthyl and Bromyl Esters by Alkali: A. McKenzie, and H. B. Thompson.

RÖNTGEN SOCIETY, at 8.15.—The Röntgen Congress in Berlin: Dr. W. Deane Butcher.

FRIDAY, JUNE 2.

INSTITUTION OF MINING ENGINEERS (in the Rooms of the Geological Society), at 10.30 A.M.—The Conveyor-system for filling at the Coal-face, as practised in Great Britain and America: W. C. Blackett and R. G. Ware.—Underground Fires at the Greta Colliery, New South Wales: J. Jeffries.—The Geology of Chunies Poort, Transvaal: A. R. Sawyer.—Underground Horses at an Indian Colliery: T. Adamson.—Description of the Eimbeck Duplex Base-line Bar: W. Eimbeck.

GEOLOGISTS' ASSOCIATION, at 8.—Note on a Piece of Mosasaurian Jaw obtained by G. E. Dibley from the Chalk of Cuxton, Kent: Dr. A. Smith Woodward.—The Chalk Area of North-east Surrey: G. W. Young.

SATURDAY, JUNE 3.

ROYAL INSTITUTION, at 3.—Exploration in the Philippines: A. H. Savage Landor.

MONDAY, JUNE 5.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploring Journeys in Asia Minor: Colonel P. H. H. Massy.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Manufacture and Use of Art Papers: R. W. Sindall.—The Influence of Gelatine Sizing on the Strength of Paper: C. Beadle and H. P. Stevens.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

TUESDAY, JUNE 6.

ZOOLOGICAL SOCIETY, at 8.30.—Notes on the Natural History of Western Uganda: Colonel C. Delmé-Radcliffe.—Descriptions of New Species of Œdionychis and Allied Genera: M. Jacoby.—On the Intestinal Tract of Mammals: Dr. P. C. Mitchell.

WEDNESDAY, JUNE 7.

ENTOMOLOGICAL SOCIETY, at 8.—New African Lasiocampidæ: Prof. C. Aurivillius.—Rhynchota collected by Dr. A. H. Willey at Birara and Lifu: G. W. Kirkaldy, with an introduction by Dr. David Sharp.

GEOLOGICAL SOCIETY, at 8.—The Microscopic Structure of Minerals forming Serpentine, and their Relation to its History: Prof. T. G. Bonney and Miss C. A. Raisin.—The Tarus of the Canton Ticino: Prof. E. J. Garwood.

VICTORIA INSTITUTE, at 4.—Annual Meeting. The Earl of Halsbury will take the chair.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Separation of Strychnine and Brucine: D. L. Howard.—Ammonium Oxalate, its Formula and Stability: P. V. Dupré.—(1) Notes on some Abnormal Milks from Cleveland and South-east Durham; (2) A Simple and Convenient Camera for Photomicrographic Work: A. C. Wilson.—The Composition and Analysis of Milk: H. D. Richmond.

THURSDAY, JUNE 8.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: (1) On the Thermoelectric Junction as a Means of Determining the Lowest Temperatures; (2) Studies with the Liquid Hydrogen and Air Calorimeters: Sir James Dewar, F.R.S.—Colours in Metal Glasses, and in Metallic Films and Metallic Solutions: J. C. M. Garnett.—Correction to Dr. H. A. Wilson's Memoir "On the Electric Effect of Rotating a Dielectric in a Magnetic Field": S. J. Barnett.—On the Application of Statistical Mechanics to the General Dynamics of Matter and Ether. The General Method of Statistical Mechanics: J. H. Jeans.—On the Magnetic Qualities of some Alloys not containing Iron: Prof. J. A. Fleming, F.R.S., and R. A. Hadfield.—On the Phosphorescent Spectrum of Sδ and Europium: Sir William Crookes, F.R.S.—On the Perturbations of the Bielid Meteors: Dr. A. M. W. Downing, F.R.S.—The Pharmacology of Indaconitine and Bikhaconitine: Prof. J. T. Cash, F.R.S., and Prof. W. R. Dunstan, F.R.S.—And other papers.

ROYAL INSTITUTION, at 5.—Electromagnetic Waves: Prof. J. A. Fleming, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—On a Class of Many-valued Functions Defined by a Definite Integral: G. H. Hardy.

FRIDAY, JUNE 9.

ROYAL INSTITUTION, at 9.—Submarine Navigation: Sir William White, K.C.B., F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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THURSDAY, JUNE 8, 1905.

A MANUAL OF QUATERNIONS.

A Manual of Quaternions. By Prof. Charles Jasper Joly, F.R.S. (London: Macmillan and Co., Ltd., 1905.) Pp. xxvii+320. Price 10*s.* net.

PROF. C. J. JOLY'S "Manual of Quaternions" is an important addition to the literature of the subject. It at once takes rank with Tait's "Treatise" as an eminently serviceable exposition of Hamilton's great calculus.

Hamilton's own works, the "Lectures" and the "Elements," are in their way inimitable. Unfortunately, their style is not suited to the average student eager to acquire a working knowledge of the mathematical method developed in them. Tait alone of the younger contemporaries of Hamilton seemed to have been able to appreciate the "Lectures"; but he himself used to relate how, as he laboriously read through the first six, he began to despair of his own powers. There seemed to be such diffuse discussion, and withal so little apparent progress. But the seventh lecture came like a transformation scene. Every page displayed new beauties, every paragraph disclosed the marvellous power and variety of the method. From it Tait drew his inspiration, and proceeded to enlighten the world as to the meaning and purpose of the quaternion.

To the student who has grasped the essentials of the method Hamilton's second volume, the "Elements," will always prove a happy hunting ground; but experience has shown that its very completeness acts as a deterrent. In the much smaller treatise written by Tait, the important practical aspects of quaternions are more rapidly though less logically developed, and the chief value of Tait's work lies in his characteristic treatment of dynamical and physical problems. It has been long felt, however, that a good working manual of quaternions was needed, by use of which the mathematical student could come quickly into touch with all that is essential in the calculus. This is what Prof. Joly has endeavoured to supply.

For reasons clearly explained in the preface, the author has (reluctantly, he confesses) forsaken the Hamiltonian approach. Instead of developing the calculus logically from the definition of a quaternion as the ratio of two vectors, he defines independently the quantities $S\alpha\beta$ and $V\alpha\beta$, and then writes the product $\alpha\beta$ as equal to the sum of these two. The student must, of course, take on trust that there is some good reason for defining $S\alpha\beta$ as *minus* the product of the length of one vector into the length of the projection of the other upon it. This is, at root, the peculiarity of Hamilton's system which troubled O'Brien nearly sixty years ago, and has not ceased to trouble occasional critics since. There is a kind of notion hovering about in some minds that the positive sign in algebra is more natural than the negative sign, the truth being, of course, that the one necessarily implies the other. It is to be feared, however, that this apparently arbitrary assumption of the negative sign in translating $S\alpha\beta$ into ordinary trigonometrical notation (Clifford calls it a *convention*) will puzzle many a student. Prof. Joly soon gives the reason for the negative sign, though not quite so definitely as might be desirable; but it is questionable if its full significance will be appreciated until considerable progress has been made in acquiring quaternionic skill. The reader is advised to exercise a strong faith, and to proceed nothing fearing. If he persevere he will soon get out of the valley of the shadow of the negative sign.

It is possible that some critic may regard this forsaking of Hamilton's logical basis as a confession of weakness. But this is not so. The weakness is in the average student, for whom a somewhat simple intellectual diet must be prepared in the hope that the mental digestion may be strengthened sufficiently to assimilate the strong Hamiltonian food which Prof. Joly serves up a little later. The truth is that very few students are able to appreciate to the full an absolutely logical argument until they have a certain amount of practical knowledge imparted to them more or less by authority.

So far as the *principle* of the method is concerned, Prof. Joly ranges himself at first on the side of those vector analysts who neglect the quaternion. But it is only for a couple of pages at the beginning of chapter ii. On p. 8 the important formula

$$(\alpha\beta = S\alpha\beta + V\alpha\beta)$$

is introduced as a definition of the quaternion, and the quaternion is never afterwards lost sight of. Its fundamental importance and analytic value are in evidence on every page. It must be admitted that by this line of approach the reader is rapidly brought into touch with the essential elements of the subject. There is, nevertheless, a certain arbitrariness which is not satisfying to the mind, nor is it clear when all is done what is really fundamental. A critically minded student might possibly be inclined to say, Why not define $S\alpha\beta$ as *plus* the product of the lengths of the vectors into the cosine of the angle between them, and then define the quaternion $\alpha\beta$ by the formula $V\alpha\beta - S\alpha\beta$? At first sight it seems to amount to the same thing, and yet, as will be found on trial, it leads to a system clothed in quaternion garments, but more like the fabulous ass in the lion's skin than the real lion.

Having thus established in chapter ii. the fundamental properties of the quaternion, Prof. Joly rapidly runs over certain important transformations of vector products and ratios (chapters iii. and iv.), and simple applications to the geometry of the straight line, plane and circle (chapters v. and vi.). Then follow, treated in separate chapters, differentiation, linear vector functions, quadric surfaces, and the geometry of curves and surfaces. Here the *power* of the calculus asserts itself strongly. Numerous examples are supplied throughout for the student to work upon and develop his analytical skill. In subsequent chapters dynamical problems of various kinds are taken up—such as astatic equilibrium, screws and wrenches, strains, central forces, constrained motion, motion of a rigid body, and the like. A valuable and well arranged chapter on the operator ∇ treats of heterogeneous strain, spherical harmonics, hydrodynamics, elasticity, electromagnetic theory, and wave propagation generally. The

treatment is by no means superficial, and is in many places highly condensed. It is all done in forty-two pages, a remarkable testimony to the compactness of quaternion notation and the brevity of quaternion proofs. In chapter xvii., on projective geometry, Prof. Joly gives his own interesting extension, in which a new interpretation is assigned to the quaternion, and he concludes in chapter xviii. with quaternions generalised so as to be applicable to space of any number of dimensions.

There can be no question as to the high merits of the "Manual of Quaternions." It is a worthy companion volume to the master's own great works. Like the "Elements" of Hamilton and the "Elementary Treatise" of Tait, it is characterised by the extraordinary range of mathematical subjects which come within its scope. It is not merely the substitution of one symbol for three or one for four which makes this condensation possible, for that, after all, is a question simply of notation. But the quaternion calculus rejoices in the possession of two remarkable operators, the linear vector function ϕ and the vector differentiator ∇. They operate singly and in combination according to laws which naturally evolve themselves from the fundamental laws of the calculus. They can be linked together in an endless variety of ways, and go far to give to Hamilton's quaternions a flexibility, power, and pictorial compactness not possessed by any other general method which is directly applicable to problems of mathematics pure and applied. These features are exquisitely brought out in Prof. Joly's "Manual." C. G. K.

SOME MEDICAL WORKS.

(1) *New Methods of Treatment.* By Dr. Laumonier. Translated from the second revised and enlarged French edition, and edited by Dr. H. W. Syers. Pp. xvii+321. (London: Constable and Co., Ltd., 1904.) Price 7s. 6d. net.

(2) *The Surgery of the Diseases of the Appendix Vermiformis and their Complications.* By W. H. Battle and E. M. Corner. Pp. xi+208. (London: Constable and Co., Ltd., 1904.) Price 7s. 6d. net.

(3) *Clinical and Pathological Observations on Acute Abdominal Diseases.* (The Erasmus Wilson Lectures, 1904.) By E. M. Corner. Pp. 98. (London: Constable and Co., Ltd., 1904.) Price 3s. 6d. net.

(4) *A Short Treatise on Anti-Typhoid Inoculation.* By Dr. A. E. Wright. Pp. x+76. (London: Constable and Co., Ltd., 1904.) Price 3s. 6d. net.

(5) *The Suppression of Tuberculosis.* By Prof. E. von Behring. Authorised translation by Dr. Charles Bolduan. Pp. v+85. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 4s. 6d. net.

(1) EVERY year a multitude of substances, chiefly synthetic, is introduced, every one being extolled as a certain cure for this or that ailment. By good fortune one of them is now and then found to be of real value, and for a time at least finds a place in the "aramentaria medica," but the majority in a year or two pass into oblivion. Similarly new modes of treatment come and go, most of them being of little worth. But the medical practitioner is expected to know of all these medicinal substances and vagaries of treatment, and must be prepared to employ any one of them at the suggestion of some faddist who happens to consult him. From this point of view the first book on our list may be a useful guide, but otherwise one would be inclined to ask, *cui bono?* Some of the substances included in the volume are by no means new, *e.g.* thyroid, guaiacol, and the antitoxic sera, while others which have a greater claim to novelty, and are, moreover, of real value, such as aspirin, acetozone, urotropine and cystamine, and purgen, are omitted. In dealing with tetanus antitoxin, no mention is made of injection into the spinal cord or nerve trunks. As regards phosphorised principles, lecithin, glycerophosphates, &c., which have of late been extolled in wasting diseases and nervous affections, the administration of a couple of eggs a day would probably be of far greater benefit than any of the medicinal preparations of these substances.

(2) Messrs. Battle and Corner give a succinct account of the anatomy, pathology, symptoms, and treatment of that common and fashionable malady appendicitis which may be safely recommended as a guide for the medical practitioner. The origin and function of the vermiform appendix are discussed; that little blind tubular appendage of the bowel inflammation of which gives rise to so much trouble. The appendix has usually been regarded as a vestigial structure and useless in function, but the researches of Mr. R. Y. A. Berry, of Edinburgh, suggest that it is a specialised mass of lymphoid tissue which the authors conceive may serve as a defensive mechanism against bacterial invasion in a portion of the bowel where, for anatomical and other reasons, there is a delay in the passage of the intestinal contents onwards, and special protection is therefore required against the absorption of bacterial products.

(3) This work is based on material collected in compilation of the Erasmus Wilson lectures, 1904. The author states that the main object of his lectures was to direct attention to the identity of the pathological changes concerned in the production of all acute perforative and gangrenous processes of the alimentary tract. He suggests that two extremes of tissue death or necrosis may be recognised, viz. that due to deprivation of blood and that caused by the action of micro-organisms. Between these two there are various grades and admixtures; the former is slow in action, the latter very rapid, and it is this which plays so important a part in abdominal necrosis. The work is practically a collection of notes, but is interesting reading.

(4) Prof. Wright has done well to collect into a single volume the various papers, with amplifications, he has from time to time contributed to various journals on the subject of anti-typhoid vaccination. The method of preparation of the vaccine, theoretical and practical considerations as to its use, and statistics of its value are all considered. With regard to the last named, it must be mentioned that some controversy has taken place in the medical Press as to

the validity of Prof. Wright's conclusions from the statistical evidence.

(5) This little book should be in the hands of every hygienist, and, since it deals largely with bovine tuberculosis, of every scientific stock owner. Behring is one of those who not only disbelieves the dictum of Koch of the essential distinction between human and bovine tuberculosis, but goes to the other extreme, and asserts that "the milk fed to infants is the chief cause of consumption," and he would insist on the pasteurisation of all milk. He asserts that pulmonary tuberculosis (phthisis or consumption of the lungs) is not an infection from inhaled tubercle bacilli. Besides pasteurisation, Behring also recommends the use of formalin as a preservative of milk, a procedure which will probably not commend itself to the authorities here, though there is a good deal to be said in its favour. Finally, he describes a method of vaccinating cattle against the tubercle bacillus by the aid of which he hopes eventually to stamp out bovine tuberculosis, and as a consequence human tuberculosis, a consummation devoutly to be hoped for.

R. T. H.

THE PIONEERS OF GEOLOGICAL THOUGHT.

Karl Ernst Adolf von Hoff, der Bahnbrecher moderner Geologie. By Dr. Otto Reich. Pp. xvi+144. (Leipzig: Veit and Co., 1905.) Price 4 marks.

THIS clearly written work, undertaken with a just enthusiasm, is a welcome and permanent contribution to the biography of scientific men. Von Hoff's position as an original thinker is at least equal to that of Lyell, though both writers, of course, found notable *Bahnbrecher* before them, in Hutton, Desmarest, and others. Karl von Zittel, in his "Geschichte der Geologie," held the balance very wisely between von Hoff and Lyell when he wrote,

"The third volume (of von Hoff's "Geschichte der . . . natürlichen Veränderungen der Erdoberfläche") is clearly influenced by Charles Lyell's first volume of the 'Principles of Geology,' which had appeared in the meantime. Von Hoff unreservedly adopts the point of view of the great British investigator; yet Lyell's views corresponded on the whole with what von Hoff had put forward ten years before as the result of his historical researches. The fact that von Hoff's meritorious work was not properly valued, and was put in the shade by Lyell's epoch-making book, which appeared almost simultaneously, is easily explained by the circumstance that the modest German man of science derived his material mainly from books, that his position did not allow him to examine in the field the questions which he discussed, and that he enriched science by no new facts; he faced his problem as a historian, and not as an observer."

Let us frankly admit, on the British side, that Lyell was not among the great original observers, and that his eminence rests on his brilliant perception of the meaning of correlated facts; yet his energy of movement and his frequent travels gave him an immense advantage over his contemporary. Dr. Reich shows us how von Hoff was occupied in many other affairs while preparing himself for his "Geschichte," a work of immense originality, and free indeed from the prejudices of his day.

In 1788 von Hoff entered the University of Jena, in his native region of Thüringia, and proceeded after two years to Göttingen. Here he found inspiration in the character and friendly help of Blumenbach; but his professional work lay in diplomacy, and in 1791 he was appointed Secretary of Legation under his own Government of Gotha, where his father was already a Privy Councillor. As in France, the scientific renaissance was accompanied by national movements that might well have extinguished private calm and study. Von Hoff was one of the delegates who, in 1806, pursued Napoleon's court from Berlin to Posen, and who secured the entry of Gotha into the saving grace of the Confederation of the Rhine. True to the interests of his State, he bore greetings to Jerome of Westphalia two years later, and helped to steer Gotha again into safe waters, this time under a German ægis, when Leipzig had seen the downfall of his alien suzerain. Yet, amid all the excitement of the times, when princes scampered rabbit-like from hole to hole, von Hoff founded a geological journal in 1801, met Werner in Gotha, and was struck by his mental limitations, spoke and corresponded heartily with Goethe, and explored the Thüringian Forest in a number of geological excursions. In the sanguinary year of 1806 he encountered Humboldt in Berlin, and the diplomat of Gotha was describing his native woodlands when the echoes of Friedland spread dismay through Germany.

In 1822 the first volume of his famous "Geschichte der durch Überlieferung nachgewiesenen natürlichen Veränderungen der Erdoberfläche" appeared from the house of Justus Perthes in Gotha; and Dr. Reich does well to press the claims of this work as the foremost and most rational attempt to free geologists from their popular catastrophic school. Dr. Reich (p. 107) quotes from Blumenbach to show that Hutton's views had spread to Germany in 1790, and that Voigt of Jena had already prepared the way by prior and independent conceptions of his own. Von Hoff surpassed Hutton in urging the power of existing causes working through long periods of time. This position had been reached by him as early as 1801 (p. 111), and his biographer is inclined on this account to accuse Lyell of overshadowing wilfully his predecessor. It is idle, however, to quote from the edition of the "Principles of Geology" issued in 1872 (p 131), in which numerous alterations and additions had led to much excision. Instead of the solitary quotation from von Hoff referred to by Dr. Reich in support of his contention, we find five references in the first edition of vol. i. (1830), and two more in the second edition of vol. ii. (1833). Five references, moreover, to von Hoff remain in the eighth edition of the "Principles," issued in one volume in 1850. Since Lyell in his first edition devoted nine pages to the views of Hutton, out of the seventy given to the history of geology, he can hardly be said, as Dr. Reich would have us believe, to have shown ingratitude to Hutton also.

In 1826, in a memorial notice of Blumenbach, von

Hoff proved how far he was prepared to go in accepting organic changes as the result of changes of the earth's surface. Side by side with a progressive development of the surface-features, he saw the necessity for a transformation in the nature of the organic world. The quotation given on p. 134 may not imply so much as Dr. Reich reads into it; but we are grateful to him for setting before us the absolute mental pre-eminence of von Hoff in the world of Continental geologists of his day, and the fact that, from one cause or another, no conception of his greatness and originality can be gained from the historical *résumé* of Lyell, with which all English readers are familiar. G. A. J. C.

MINE AIR.

The Investigation of Mine Air. By Sir C. Le Neve Foster, F.R.S., and Dr. J. S. Haldane, F.R.S. Pp. xii+191; illustrated. (London: Charles Griffin and Co., Ltd., 1905.) Price 6*s*. net.

SINCE the Hon. Robert Boyle published in 1671 his essays on "The Temperature of the Subterraneall Regions" and on "The Strange Subtilty of Effluviums," and Athanasius Kirscher devoted a chapter of his "Mundus Subterraneus" (1678) to the occurrence of inflammable gas in the Herrengrund copper mines, there has been a constant succession of memoirs dealing with the gases met with in mines. The latest addition to the series, by making accessible the results of German, French, and British investigations, should do much to add to the knowledge of the composition of mine gases and of their influence on human life. A large portion of the work was left in manuscript by Sir Clement Le Neve Foster at the time of his death, and such revision as was necessary has been undertaken by Dr. J. S. Haldane, who has added a section of great value, embodying a description of rapid methods of analysis that he himself has devised and an essay on the interpretation of mine-air analyses in the light of recent investigations.

The book is of a composite nature. The first section is a translation of the introductory treatise on mine-air analysis by Prof. O. Brunck, of the Freiberg School of Mines. The second section is a translation of a paper by Mr. Léon Poussigue on the measurement of air currents and fire damp at the fiery Ronchamp collieries, the deepest mines in France. The third and longest part contains a summary of Dr. Haldane's work on the examination of mine air. As an appendix is added a detailed account, from Sir Clement Le Neve Foster's reports to the Home Secretary, of the effects of carbonic oxide in connection with the Snaefell mine disaster in the Isle of Man in 1897. Sir Clement's exposure to carbonic oxide during the recovery of the bodies of the miners killed was the starting-point of the illness that ultimately proved fatal.

The methods of analysis for mine gases described by Prof. Brunck are simple, and in no respect less accurate than the most delicate methods of exact gas analysis. The fulness of the instructions and the simplicity of the methods should induce mining engineers to practise gas analysis and to regard it as an important guide to the safety of the workings placed under their charge.

Since November, 1891, a special department has been organised at the Ronchamp collieries for the purpose of determining the proportion of fire-damp in the workings. The Le Chatelier combustion apparatus is employed, and an assistant makes two hundred determinations a day.

In the third section the methods of determining oxygen, carbonic anhydride, nitrogen, and fire damp described by Dr. Haldane well fulfil the practical requirements of being very accurate and rapid. His method of obtaining and transporting samples of mine air in two-ounce stoppered bottles is trustworthy and much more convenient than Poussigue's method of using a 1½-litre bottle, or Winkler's method of using a 10-litre sheet-zinc vessel recommended by Brunck. One cannot help thinking that in the latter case prolonged storage in a zinc vessel would have an effect on the composition of the gas. In Dr. Haldane's dry bottles no sensible alteration of the contained sample occurs within a fortnight or more. His method of gas analysis is similar to that originally described by him in the *Journal of Physiology* in 1898; and he now describes for the first time a portable apparatus, enclosed in a wooden case measuring 7 by 12 by 2½ inches and weighing 5½lb., by means of which accurate determinations may be made, on the spot underground, of various impurities in the air. He also describes a convenient method of determining the quantity of stone-dust in the air of working places in metalliferous mines. The disastrous effects produced by the habitual inhalation of air containing stone-dust are now generally recognised. The air of an "end" or "rise" just after blasting contains large quantities of dust, and the men ought not to return until there is less than 1 milligram in 10 litres of air. The average air of a "stope" where men are working should not yield any weighable dust in that quantity of air.

Obviously a complete analysis of mine air is useless unless the significance of the results is understood. The chapter on the interpretation of mine-air analyses is consequently of far-reaching importance. Dr. Haldane advocates the use of the convenient term "black damp" for the nitrogen and carbonic anhydride. It is the gaseous residue resulting from the slow oxidising action of air on oxidisable substances in a mine. It is very commonly confused with carbonic anhydride, but it really consists chiefly of nitrogen. Black-damp, which was nothing but pure nitrogen, was described by Mr. H. A. Lee (*Proc. Colorado Scientific Society*, vol. vii., p. 163, 1904) as occurring in a metalliferous mine in Colorado. A useful section on the effects of air impurities on men concludes part iii. Much of the information in this part has already been published by Dr. Haldane in Home Office reports and in papers read before the Institution of Mining Engineers; but an authoritative summary of the results arrived at is a welcome addition to technical literature.

The book, which was originally intended for Le Neve Foster's students at the Royal School of Mines, should prove invaluable, not only to mining engineers at collieries, but also to those engaged in metalliferous mines.

B. H. B.

AN INDIAN GARDEN.

An Indian Garden. By Mrs. Henry Cooper Eggar. Pp. viii+181; illustrated. (London: John Murray, 1904.) Price 7*s*. 6*d*. net.

AN unpretentious little book, written in an easy vein, printed on very light paper and in the best of type, "An Indian Garden" might well be suited to while away pleasantly an idle hour. There is so much freshness about the book, so much enthusiasm for the author's garden, such a lovable unconsciousness of the inward triviality of the hundred and one little incidents, servant, cobra, and dog stories and harmless gossip woven into this tale of amateur gardening, that one would fain make the personal acquaintance of the writer. As we read on, our interest centres more and more in the healthy, vigorous, and amiable personality that sways this old Indian Garden of 5½ acres, whilst the garden itself, with its old trees, its amaryllis and caladium beds, its fernery, its obstreperous lawn of "Dooba" grass (*Cynodon Dactylon*), and its general propensity to run back to jungle, becomes so much background.

In those circumstances one forgets to look out for any systematic information on the conditions of gardening in India, nor is there any room for criticising seriously the author's botany. One does not stop, for instance, to ponder over the curious "almond tree" (p. 43) with the convolute embryo, or mind that the lycopodium (p. 50) "that turns a beautiful electric blue in the shade" is in reality a Selaginella (*S. uncinata*), or that the deodars (p. 141) which ripen their berries in July are evidently the debdars (*Polyalthia longifolia*) mentioned repeatedly in the earlier pages. It must all be beautiful, and one longs to see it.

We are not told where the garden is. Its whereabouts, like other things in the book, are hidden under a delightful incognito. It is just a few feet above the sea in a vast plain "with never a rise, sufficient to be called a hill anywhere near for 100 miles." It may be, and very likely it is, in Bengal, as the locality from which the preface is dated and other indications suggest; but that, again, matters very little. It is in keeping with the light, playful humour which pervades the whole book. Still, it would be unfair to pass over the fact that there are passages in it which for keenness of observation, terseness and descriptive power, rise high above the average level of the book. Thus on p. 41, "I like the Casuarinas, though they are bad gardeners, and suck up all the moisture in the earth for some long distance round their roots, so that nothing can possibly live near them; sometimes in the early morning they weep it all back copiously like rain"; or on p. 145, "If one wanted to photograph the movements of an opening blossom, one should select the *Crinum augustum*. It is a noble plant, this lily; about 4 feet high, with scented flowers, numbering 22 in a bunch at the end of a long stalk as thick as a ruler. I passed by one just after a shower of rain this evening, and noticed that four or five of the 4 inch long, pink-striped buds were just ready to open. I came by again shortly after, and lo! and behold! they *were* open, quite wide open, too. In my next turn, 20 minutes after, the long petals had entirely curled themselves backwards like rams' horns. One could see them all a-quiver with the intensity of the movement still. In one hour the points of those petals must have described an arc of 8 or 9 inches or more!"

There is a dainty coloured frontispiece representing a branch of an Antigonon (evidently *A. leptopus*)—though it is difficult to see why a representative of an exclusively American genus should usher in "An Indian Garden"—and eighteen illustrations, photographic prints, some of them veritable gems for their general beauty and exquisite clearness.

OTTO STAPF.

OUR BOOK SHELF.

Animals I Have Known. By A. H. Beavan. Pp. 304; illustrated. (London: T. Fisher Unwin, 1905.) Price 5*s*.

IF the present rate of issue be much longer maintained, popular books on mammals (or "animals," as they are still called by the man in the street) will soon begin to rival in number those devoted to birds. In the volume before us the author, without having anything specially new to communicate, discourses pleasantly enough on the mammals (both wild and domesticated) of our own islands, as well as on those of two other countries, namely, Australia and South America, with which he is personally familiar. His anecdotes and descriptions are emphasised by the numerous reproductions from photographs with which the work is illustrated. Most of these are first rate, the one of the thylacine, or Tasmanian wolf, showing to perfection that gradual merging of the tail in the body to which the author specially alludes, and which so markedly distinguishes many of the lower mammals from their more specialised relatives.

Unfortunately, the text is marred by a number of more or less inexcusable blunders and errors, which cannot but deceive the class of readers for whom the book is intended. On the very first page we are told, for instance, that there lived in Britain during the mammoth period "tapir-like three-hoofed creatures with long snouts." This can evidently be nothing else than the Oligocene palæotherium, an animal to which reference is again made on p. 279, where the author observes that he has momentarily forgotten its name—a nice admission to make in print! A similar "muddle" in regard to palæontological chronology is made on p 16, where we find opossums included among the British Pleistocene fauna. Even more serious is the deliberate statement on p. 222 that the duckbill, or platypus, is the only known oviparous animal—more especially in view of certain doubts that have been expressed of late years as to whether this species does actually lay eggs. Again, on p. 291 we are told that all South American monkeys are furnished with prehensile tails, while ten pages later we are informed that the vampire bat taps the blood of its victims with its canine (instead of incisor) teeth. Moreover, in the plate on p. 299 the author figures as that of the true blood-sucking vampire the head of a javelin-bat (Phyllostoma) or a nearly allied species. Possibly the latter species may occasionally suck blood, but it is not the vampire *par excellence*. In the figures of a bat on p. 91, which

may be presumed to be intended for the pipistrelle, the tail is entirely omitted, so that there is nothing to support the median extension of the interfemoral membrane! The following remarkable sentence (p. 202), we are glad to acknowledge, is not typical of the author's style:—"The koala's habits are sluggish, and though able to climb well, moves about the trees in a most deliberate manner." R. L.

Queen-Rearing in England, and Notes on a Scent-producing Organ in the Abdomen of the Worker-Bee, the Honey-Bees of India, and Enemies of the Bee in South Africa. By F. W. L. Sladen. (Houlston and Sons, 1905.)

THE scope of this little work by a practical bee-keeper is sufficiently indicated by its title, and the bulk of its contents has already appeared in the British *Bee Journal* and the *Entomologist's Monthly Magazine*. There is a coloured frontispiece representing the queen and worker of the Golden Italian bee, and there are numerous text-illustrations of no remarkable excellence After a chapter on queen-rearing in nature, several chapters are devoted to the best artificial means of securing a supply of queens for multiplying or improving bee-colonies; and a brief account is given of different races called the Italian (or Ligurian) Bee, the Golden Italian Bee, and Carniolan Bee, and the Cyprian Bee. In a later chapter Mr. Sladen remarks that when vibrating their wings, and especially when swarming, bees produce a peculiar tune which has been supposed to attract their comrades; but the author thinks the attraction is at least partly due to a powerful scent emitted when a membrane situated between the fifth and sixth dorsal segments of the abdomen is exposed. This is fully described and figured. Short chapters on the honey bees of India (*Apis dorsata, florea,* and *indica*), and on enemies of bees in South Africa; "Bee Pirates" (sandwasps belonging to the genera Palarus and Philanthus), a Tachinide parasite in the abdomen; and a species of Chelifer conclude the work.

Physical Experiments. By N. R. Carmichael. Pp. xi+127; with diagrams. (Kingston, Ontario: R. Uglow and Co., 1904.)

ANYONE drawing up an elementary course of mechanical and physical experiments, and wishing for a manual to accompany it so as to make the preparation of a special volume unnecessary, could hardly do better than adapt his course to the manual before us. It contains just the short description which would otherwise be produced by some copying process for distribution to a class, or, failing this, would probably be written on a blackboard. That is to say, there is just enough description to indicate to a pupil what he is expected to do, and which would be copied by him into his notebook. A teacher will require to amplify the book verbally, either in the course of a short demonstration at the beginning of the class, or, if his lectures and the practical work run together very well, this might sometimes be done in the course of the lectures. The aim that Mr. Carmichael has had before him has been to state concisely the nature of the quantity to be measured in each experiment and the theory underlying the method suggested. Descriptions of instruments are entirely omitted, as the students are expected to have the apparatus given them by an instructor.

With regard to the selection of experiments, the object has been to give students who have but a limited time for laboratory work a practical acquaintance with as many physical quantities as possible. The fact that the author is a teacher in a school of mining is a guarantee that the technical student is intended to be served; but it is the more academic, but equally necessary, side of his training that is here catered for.

An Introduction to Elementary Statics (Treated Graphically). By R. Nettell. Pp. 64. (London: Edward Arnold, 1905.) Price 2s.

THIS book consists of a set of graduated exercises in graphical statics. The first seventy, about half the total number, are restricted to problems on the equilibrium of three forces at a point, and are intended to be worked by means of the parallelogram of forces. In succeeding problems the triangle of forces and the polygon of forces are introduced. The principle of moments is also employed. A few examples are given of the determination of the centre of gravity of simple plane figures, and in the final examples the subject is carried as far as the equilibrium of four non-concurrent forces in one plane. The link polygon is not used, so that parallel forces are scarcely referred to. It will be seen how extremely limited is the ground covered by this book. The constructions are not founded on or verified by experimental work of any kind. No vectors other than force vectors are introduced. Trigonometrical calculations, even of the simplest kind, are rigidly excluded. The book is intended to be used by classes of young boys, but its scheme does not harmonise with the ideas now prevalent as to the way in which elementary mathematics should be taught to youths.

The Elements of the Differential and Integral Calculus. By D. F. Campbell. Pp. x+364. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1904.) Price 7s. 6d.

THIS book seems well adapted to serve as a text-book for a first course in the differential and integral calculus. Fourteen chapters deal with the differential calculus and its applications to maxima and minima values, expansions in series, and the geometry of plane curves. The fundamental ideas of integration are very fully explained, the second fourteen chapters being devoted to the integral calculus and its application to finding plane areas, lengths of curves, areas of surfaces, and volumes. In a short chapter dealing with approximate integration, the first and second elliptic integrals are introduced, and three-figure tables for $F(k, \phi)$ and $E(k, \phi)$ are given. A few elementary chapters on mechanics have been introduced, so that the student may be able to view from the mechanical, rather than from the purely mathematical, side the principles of attraction, centre of gravity, and moment of inertia. Numerous exercises, with answers, are given with each chapter. The diagrams are clear, and the type is excellent.

Völkerpsychologie. By Wilhelm Wundt. Vol. i. Die Sprache. Second revised edition. 2 parts. Pp. xv+667, x+673. (Leipzig: Wilhelm Engelmann; London: Williams and Norgate, 1904.) Price 14s. net and 15s. net; bound, 17s. net and 18s. net.

THE first volume of this monumental work has reached a second edition, some sixty or seventy pages bulkier than its predecessor (reviewed in NATURE on January 16, 1902). The most important changes affect the fourth chapter, *Der Lautwandel*, the sixth, *Die Wortformen*, and some parts of the theory of the sentence. A first edition of the other volumes, dealing with myth and custom, has not yet appeared; it is to be hoped that it will not be unduly delayed by the necessity of revising the present instalment, and that in any parts still to appear the wood will be less closely concealed by the trees.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

History of a White Rhinoceros Skull.

IN his interesting "Natural History Essays," in which occurs the description of the white rhinoceros, Mr. Graham Renshaw makes the following reference to the first skull of this animal which was brought to England:—

"It would be interesting to know if the white rhinoceros head brought to England by the Rev. John Campbell, about 1815, is still in existence. It appears to have been preserved as late as 1867 in the Museum of the London Missionary Society at Finsbury, but there seems to be no mention of it during recent years in zoological literature. In a figure now before me the artist has absurdly furnished the open jaws with an imaginary series of perfectly regular pseudomolar teeth: the square mouth has been distorted to resemble the prehensile lip of the black species, though the slit-like nostrils, position of the eye and semi-tubular ears are delineated with fair correctness. The anterior horn of this individual is said to have been 3 ft. long: and, *as figured*, from its slender-

FIG. 1.—Skull of the White Rhinoceros in the American Museum of Natural History.

ness recalls Col. Hamilton Smith's description of the mysterious horn, brought from Africa, from which he sought to deduce the existence of a true unicorn in the interior of that Continent" (p. 146).

In 1902 this very skull was purchased from Mr. Cecil Graham for the American Museum of Natural History by Mr. J. Pierpont Morgan. Mr. Graham has made a large and valuable collection of rhinoceros horn weapons, clubs, knob-kerries, and battle axes, and in course of correspondence he wrote of his discovery of the skull as follows:—"There is no record as to how or when the specimen was first brought to England. I found it by chance a few years ago in the City, lying neglected and dirty on the floor of a back room of the London Missionary Society. No doubt it was presented by a missionary before 1821. I especially value the letter dated 1821."

The letter referred to by Mr. Graham is from William Cooke, of the Royal College of Surgeons. It is dated November 20, 1821, and addressed to William Alers Hankey, Esq., Fenchurch Street. It reads as follows:—

"My dear Sir,

"The head in the missionary museum supposed to be the head of the unicorn, appears to belong to a species of Rhinoceros previously unknown in this country, at least, there is no such specimen in the Hunterian Museum which may be regarded as the National Depository for comparative anatomy. In that grand collection there are heads which nearly resemble it, but there are points in which the diversity of conformation indicates a decided *specific* difference.

"Permit me to suggest to you, and through you to the Directors of the Missionary Society, that a rare specimen of that nature is entitled to a place where it can be more justly appreciated than it ever will be in their collection. I need not suggest to you the advantages which result from a concentration of the different productions of nature—from bringing under one view the genera and species of the various natural sciences—especially when they are not only rendered available for minute distinction, but by a liberal policy are accessible to men of science from all parts of the world. I can have no selfish motive in suggesting that the head possessed by the Missionary Society would become much more an object of interest if deposited in the Hunterian Museum, than it ever will be should it remain in the Old Ivry. If deposited at the College of Surgeons it will not only fall under the notice of Naturalists from all quarters, but it will likewise be a subject of reference in the lectures on comparative anatomy annually delivered at that Institution.

"The Missionary directors unquestionably will consider the advantages which may result to their own Society, as well as the promulgation of scientific knowledge; and if I might presume to express an opinion on this subject, it would be in favour of the head being presented to the College. It would there be preserved as a testimony of praiseworthy liberality—it would soften prejudice, where perhaps there is a deep-rooted antipathy to religion, but where conciliation is of great importance; and if it remain in its present situation for a few years it will be liable to destruction, or to essential injury at least.

"If you have never seen the Museum of the College of Surgeons it would afford me great pleasure to accompany you thither any Friday.

"I feel assured, my dear Sir, that you will excuse the liberty I have taken in addressing you on this topic;—and believe me to be

"Yours most obediently and
"respectfully
"(signed) WILLIAM COOKE."

In spite of this appeal, the skull evidently remained in the possession of the Missionary Society until Mr. Graham rescued it from oblivion. Although the occipital portion has been sawn off, it is a remarkably fine specimen, as shown by the accompanying photograph. The nasal horn is firmly attached to the skull; the frontal horn is detachable, but readily fits in place. The principal measurements are as follows:—

Total length of skull, along top ..	778 mm.	$=30\frac{5}{8}$ inches
Length of grinding series	287 ,,	$=11\frac{1}{4}$,,
,, frontal horn	280 ,,	=11 ,,
,, nasal horn	890 ,,	=35 ,,

(Measured on a straight line.)

The skull is now exhibited with two war clubs manufactured from the nasal frontal horns of the white rhinoceros, with a skull of the related woolly rhinoceros from Siberia, presented by the Moscow Museum, through Madame Pavloff, also with a skull of the *Rhinoceros pachygnathus*, a related or ancestral form, from Pikermi, presented by the Munich Museum through Prof. von Zittel.

HENRY FAIRFIELD OSBORN.

American Museum of Natural History, New York,
April 24.

Fictitious Problems in Mathematics.

YOUR reviewer gives a new definition of "a perfectly rough body" (NATURE, June 1), which he says is that of the mathematician. The definition appears to me to contradict what he has elsewhere said. But I need not enlarge on this point, for his criticism of a problem should be tried, not by his definition, but by that given in the book in which the problem occurs.

The reviewer accuses Cambridge examiners "of endowing bodies with the most inconsistent properties in the matter of perfect roughness and perfect smoothness"

(NATURE, April 27). He adds, as an explanation, that "the average college don" forgets an elementary law of friction. But the proper inference is that the definition of the reviewer is different from that in common use. It is difficult to believe in this general forgetfulness.

The various letters sent to NATURE sufficiently show what meaning is usually attached to the words.

June 3. E. J. ROUTH.

WHY JAPAN IS VICTORIOUS.

TEN years ago, after the conclusion of the war between Japan and China, it was remarked that the sound of the Japanese cannon at the mouth of the Yalu River awoke the nations of the world to the fact that a new Power had arisen in the Far East which in future would require to be taken into account when any political problems arose. It is, of course, recognised by all who know modern Japan that the most important factor in the making of new Japan has been the applications of science to the arts both of peace and war. Without these, even the spirit of the samurai would have been as powerless before the attacks of Western Powers armed with all the latest warlike appliances, as were the dervishes at the battle of Omdurman. Spectators speak with admiration of the bravery of these men and with pity that their lives were thrown away in a vain resistance. Without the help of science and its applications it is very certain that, before this time, Japan would have been overrun by a European Power after immense slaughter, for the last man would have died, fighting with his primitive weapons, rather than recognise a foreign domination.

A careful study of the evolution of modern Japan shows plans founded on enlightened principles and carried out in every detail. In fact, one of the secrets of the success of the Japanese in the present war is that nothing is left to chance; every detail is worked out and carefully provided for. They soon recognised that their national ideals would never be realised without a system of education, complete in every department, which would supply the men who were required to guide the nation under the new conditions which had emerged. Elementary education was organised all over the country, secondary education in central districts, and technical education wherever it seemed to be required. Above all, there are two national universities which in equipment and quality of work done will bear favourable comparison with similar institutions in any other country in the world.

The educational work of the country was directed not simply to personal or sectional purposes, as is unfortunately too often the case in the West; it was also consciously directed to the attainment of great national ends. Every department of the national life was organised in a rational manner, and, therefore, on scientific principles. In many departments there is still much to be done, but past achievements promise well for the future.

Special attention has been paid by the Government to the applications of science. Without the railways, the telegraphs and telephones, the dockyards, the shipbuilding yards, the mines, and the engineering establishments, the existence of the army and navy would have been impossible; at least, if they did exist they would have been nearly powerless. The operations of the present war with Russia have clearly demonstrated the importance of the introduction of the scientific spirit into all the national activities. The railways which have been built in Japan have been fully utilised to convey men and materials and the ships to transport them oversea. The telegraphs have been used to communicate instructions and to keep the authorities informed regarding movements and requirements. The dockyards and shipbuilding yards have been ready to undertake repairs, and the arsenals and machine shops to turn out war material of all kinds, as well as appliances which aid operations in the field. Light railways have been laid down on the way to battlefields, and wireless telegraphy and telephones to convey instructions to the soldiers; in short, all the latest applications of mechanical, electrical, and chemical science have been freely and intelligently used.

The Japanese have not only modified Western appliances to suit their conditions, but they have also made numerous distinct advances. The ships of their navy are probably the best illustration of the Japanese method of procedure. In naval matters they accepted all the guidance the Western world could give them, but at the same time they struck out a line of their own, and the fleet which they have created is unique in the character of its units. British designs have in many respects been improved upon, with the result that they have obtained in their latest ships many features which have won the admiration of the world. The training of Japanese naval officers is very complete in every way, and in some respects offers an example to the British authorities, and the men are devoted to their profession. Japan now sends her picked men to Europe to complete their studies, so that in every department of national life they are kept up with the latest developments. The siege of Port Arthur, the battle of Mukden and the other battles in Manchuria, and the exploits of the Japanese Navy prove most distinctly that they have profited by their experience.

The intense loyalty of the Japanese, which compels them to make any sacrifice, combined with their great intellectual ability, enables them to take full advantage of the modern science and organisation necessary for the attainment of the objects of their ambition. Their great power of foresight prepares them for all their enterprises, both of peace and war, with exact and scientific precision. While they are permeated by Eastern ideas they have been able to appropriate much that is best in Western thought, and thus they unite many of the best qualities of the East and the West.

The lesson which our educationists and statesmen have to learn from Japan is that the life of a modern nation requires to be organised on scientific lines in all its departments, and that it must not be directed chiefly to personal ends, the attainment of which may, to a large extent, intensify many of our problems, but that it be consciously used for the promotion of national welfare.

But though the lesson is plain enough, apparently it is not understood by those whose business it is to promote national welfare by guidance or counsel. With one consent our newspapers have attributed Japanese success to all reasons except the right one; and, instead of opening the eyes of the nation to our pressing needs and deficiencies, they have been blind leaders of the blind. Our public men and our Press will not see that scientific education has brought Japan to her present position in thirty years, and that, if we choose to educate ourselves, we may arrive at the Japanese standard of national efficiency. The progress which this country has made since the Middle Ages is due to the discoveries of men of science, whose work has been done in spite of discouragement or national indifference. In the new atmosphere of Japan a scientific spirit prevails, which encourages development, with the result that the nation has in a generation arrived at a position which has taken us centuries to reach. It is not compli-

mentary to us as a nation to say that our patriotism, fear of death, or nerves compare unfavourably with similar attributes of the Japanese; and, after all, this is a matter of opinion. The fact to face is the transformation which science has effected in Japan, and the sooner our statesmen are educated to see it, the more promising will be the outlook for the British nation.

SOLAR CHANGES AND WEATHER.

DURING the last few years more than usual attention has been paid to the question of the relationship between sun-spots or prominences and "weather," and to the possibility of being able in the near future to forecast the characters of approaching seasons. Quite recently in this Journal (vol. lxxi. p. 493, March 23) we referred briefly to a pamphlet published by the United States Department of Agriculture, Weather Bureau, summing up the general state of the problem of long-range weather forecasting. In this it was stated that advances in the period and accuracy of weather forecasts depend upon a more exact study and understanding of atmospheric pressure over large areas, and a determination of the influences, probably solar, that are responsible for normal and abnormal distributions of atmospheric pressure over the earth's surface.

In the April number of the *Popular Science Monthly* the question of the relationship between sun-spots and weather is summarised in an article by Prof. Ernest W. Brown, of Haverford College. In this we have an interesting account of the problems waiting solution, and he brings together in a very clear manner a general survey of the relationship, or rather non-relationship, as he concludes to be the case. Thus he says, "it is highly probable that the direct effect of the spotted area is unimportant compared with the effects produced in our atmosphere by other causes." In his final summing up he remarks that his opinion is expressed by Prof. Cleveland Abbe, who stated that:—"The key to the weather problem is not to be found in the sun or indeed in any external influence, but that the solution is to be worked out by the conditions which hold in the atmosphere itself—conditions which can only be discovered by a thorough examination of the internal laws of motion, quite apart from any external forces which may modify the results."

In referring to the difficulties which are met with in examining the meteorological conditions on the earth's surface, Prof. Brown points out that observations made "at one place should be kept separate from those at other places, for it is theoretically possible and even probable that a maximum at one place of observation may occur at the same time as a minimum at another place. For example, the yearly averages might show that a maximum rainfall in one place always occurred with a minimum rainfall in another and *vice versâ*."

In the last quotation Prof. Brown makes a suggestive remark which recent work has shown to be an actual meteorological fact; it has already been completely established for pressure, and must therefore hold good as regards rainfall, since the latter depends on the former.

In the case of these variations of barometric pressure it has been shown, and referred to at some length in this Journal (vol. lxx. p. 177, June, 1904), that there exists a barometric see-saw on a large scale the presence of which has been amply corroborated by Prof. Bigelow, of the United States Weather Bureau. There seems little doubt that it is this pressure change that will eventually prove the "key" to the situation, and its solar origin has already been suggested in the changes in the frequency of prominences, which are, after all, allied to sun-spots.

Up to the present time those who have been attempting to explain variations of weather on the supposition of solar changes have been looking for the effect of solar action as either increasing or decreasing simultaneously the rainfall over the whole earth. The consequence has been that a study of a great number of statistics has shown that in some regions the rainfall varies directly with the number of sun-spots, and that in others the variation is inverse, while, again, in other parts there seems to be no apparent relation at all. In fact, these deductions, though quite correct, have led to the conclusion that the solar connection is of a very questionable character, as it was considered impossible for such opposite results as the first two just named to have their origin in one solar change.

It is the employment of this incorrect working hypothesis that has probably retarded the progress of the study of the connection between solar and meteorological changes.

The now recognised existence of this barometric see-saw shows that the sun's action must have a *double* effect on our atmosphere, and this of an opposite nature. Such a result is quite natural, and it is curious that use has not been made of it before.

When it be considered that the amount of air in our atmosphere is a constant quantity, a greater piling up of it on one side of the earth must necessarily mean a diminution in the antipodal regions. If greater heating power of the sun takes place, then the atmosphere must also be heated to a greater extent, and consequently more intense up-currents of warm air are formed, resulting in more pronounced low-pressure areas. There must, however, be a compensating effect somewhere, and this is found on the opposite side of the earth when the previously heated air arrives, descends, and creates an area of excess pressure.

This backward and forward transference of air becomes, therefore, of great importance in studying the weather changes in any one region, because the rainfall phenomena are so closely related to the pressure changes.

Away from the middle portions of those two large areas which behave in this see-saw manner, the variations of pressure should, and actually do, have a different periodic nature. It is of extreme importance, therefore, when trying to trace the sun's action on our atmosphere, to separate the regions over which the variations may be truly solar from those which exhibit variations modified by the mechanism of the atmosphere itself.

There is therefore no reason why we should take a pessimistic view of the attempts made to solve this fascinating riddle of the relationship between changes of solar activity and the vagaries of the weather. An enormous amount of accumulated material is ready for discussion, and efforts should be made to secure the continuity of these observations and at the same time to coordinate the data along lines most suitable for this particular research.

WILLIAM J. S. LOCKYER.

THE SURVEY OF INDIA.[1]

THE extracts from the narrative reports of the Survey of India for the years 1902–3 are contained in a thin and attenuated volume of some eighty pages, which, as compared with previous reports, represents the effects of Indian financial economy applied to one of its most interesting departments.

[1] "Extracts from the Narrative Reports of the Survey of India for the Season 1902–3." (Calcutta: Government Printing Office, 1905.) Price 2s. 3d.

A committee is now sitting somewhere in India to decide on the best method of increasing the efficiency of the Indian survey department from the point of view (amongst others) of the English expert. It may be doubted whether the Indian surveyor has much to learn from the English expert, excepting in the science of map reproduction; but it may be that the Indian financier will learn therefrom that the way to improve and develop a department is not to starve it under the pressure of each successive spasm of financial depression, but to give consistent support to its work in the field and encourage the publication of such results as are of world-wide interest. Compare this half-starved production with the survey reports of North America, of Canada, of any Continental country, or even with the intermittent publications of South America, and it would really appear as if India offered no field for scientific research that was worth a descriptive record. The report is unworthy of the Government of India.

There is apparently but one triangulation party now existing in India which works on geodetic principles, and this is gradually pushing its network of triangles through Burma, giving a good basis for two topographical surveys to extend their minor triangulations and lay out a framework for detailed mapping. Only these two topographical parties figure in the report, and the narrative of their progress is confined to the dullest of all dull statistics. Yet one of them is working in the Shan States on the Chinese frontier, where, if anywhere in the eastern world, there must be a most delightful field for new experiences and original observation.

Of geographical exploration on or beyond the Indian frontier, or of scientific investigations in the Himalayas, there is not a word in the report; nor, for that matter, is there the faintest reference to the solid work of the revenue and forest surveys which are spread in more prosaic form over half the continent. Possibly there may be much of really stirring narrative rendered by the officers concerned in trans-frontier work to which it is not deemed well to make any allusion. This is comprehensible on the grounds of political prudence, but the worst feature of this form of suppression is that it is apt to be permanent. A report once pigeon-holed in an Indian office might almost as well be solemnly committed to the earth with a spade. The man who wrote it, and who knew what he wrote about, leaves India at the mature age of fifty-five, and thereafter has nothing further to say to it. His opinion is never consulted, and it becomes merely a matter of academic interest to him to watch a new generation of frontier administrators floundering along by the light of experiences gained, let us say, in South Africa or in Egypt. He faintly wonders what has become of all the detailed information of the Indian frontier gathered in his time at the cost of so much labour and expense.

There is, however, doubtless much to be learnt from the series of tidal, levelling, and magnetic tables which take up nearly fifty of the eighty pages of the report, although it is not easy to recognise their claim to be considered narrative. Presumably these tables are published for the benefit of the comparatively few men of science who are interested in these special classes of investigation, but they hardly seem to justify the title of the report, and should certainly be preserved (as they probably are) in other forms more readily accessible for purposes of reference.

There is an account of a local survey (including levelling operations) which was undertaken for the benefit of the salt revenue department in order to ascertain the source of the Sambhar Salt Lake water supply. The result of the investigation would have been interesting had it been stated. The lake was surveyed thirty-eight years ago, and the source of supply carefully examined then. Probably the report was pigeon-holed.

It would be pleasant to congratulate Colonel Longe on the success of his first administrative report as Surveyor-General of India, but, as a matter of fact, it is obvious that hardly even the skirts of narrative have been touched so far as the Survey of India is concerned, and we can only hope that there may be another and a more comprehensive report issued hereafter in some other form.

T. H. H.

NOTES.

It cannot be too often emphasised that Japan owes its triumphs chiefly to the adoption of the scientific spirit as the essential principle of national progress. The State that accepts this axiom of practical politics secures for itself a place among leading nations; while, on the other hand, the country that gives little or no encouragement to science must fall behind in the future. The Paris correspondent of the *Times* states that this view is taken by M. Ludovic Naudeau, who, in the course of a telegram from Tokio on the causes of the Russian defeat, remarks:—"It is now idle to attempt to hide the fact that never was the Russian lack of science, of the modern spirit, or, to speak frankly, of intelligence—never was the absence of training and of enthusiasm which retards the efforts of the whole Empire displayed in a more melancholy fashion than in the Sea of Japan. All the Russian inferiority is in the intellectual sphere." We understand that even in the midst of the war, the subject of education is being keenly discussed in Japan. In our own country it is necessary to urge that satisfactory provision for the future can only be made by taking a wide view of scientific education, and by insisting that all who have the affairs of State under their control should possess such a knowledge of the methods of science as will enable them to understand that the most potent factors of success in the arts of peace or of war are scientific education and research.

Under the name of the Potentia Organisation, an international association has been formed with the object of establishing among nations a mutual relationship and cooperation for the diffusion of accurate information and unbiased opinion concerning international events and movements, and to combat narrow, prejudiced, and often interested views and news that contribute so much to international mistrust and misunderstanding. It is proposed to publish throughout the world, through the medium of newspapers and reviews, statements of simple fact and expressions of opinion by eminent public men of all nations on all important political, social, philosophical, economic, scientific, and artistic questions, to present the sincere views of experts on all current international events, and to refute false or biased news and views calculated to spread error and to endanger the peace and progress of the world. A cosmopolitan alliance of this kind should meet with many adherents in the world of science, in which the sole aims are the discovery of truth and the extension of natural knowledge. We trust that the organisation will do something to show that scientific culture is at the foundation of all national progress.

Mr. Stanley Gardiner, leader of the Sladen Trust Expedition for the exploration of the Indian Ocean between Ceylon and the Seychelles in H.M.S. *Sealark*, has sent Prof. Herdman a letter from Colombo (May 7) in which he gives the following provisional programme:—Leave

Colombo May 8, arrive Chagos Archipelago about May 20, and work there until about July 15; arrive Mauritius about August 1, and stay until about August 15; arrive Seychelles about September 8, leave about September 15, and return there on October 15 after visiting the various Amirante Islands. A second steam-launch has been acquired, and Mr. Stanley Gardiner considers that he is now fully equipped for work. The expedition will probably be next heard of from Peros Banhos, which ought to be reached early in June.

A REUTER telegram of June 1 states that a severe earthquake shock was felt in the morning of that day throughout the whole of Montenegro.

WE regret to see the announcement of the death of Mrs. Emma Hubbard, who at various times contributed to our correspondence columns interesting observations on natural history, more particularly on the subject of birds and their ways. Mrs. Hubbard also did useful service to science by indexing scientific works, among them being Sir Michael Foster's "Physiology" and her brother's "Ancient Stone Implements."

THE first International Congress of Anatomists will be held at Geneva, Switzerland, on August 7 to 10. The following national societies are to participate in this congress:—the Anatomical Society of Great Britain, the Anatomische Gesellschaft, the Association des Anatomistes, the Association of American Anatomists, and the Unione Zoologica Italiana. The organisation of the congress has been entrusted to a committee representing these societies, and consisting of Profs. Minot, Nicolas, Romiti, Symington, and Waldeyer. The presidents thus far named are Prof. Sabatier, of Montpellier; Prof. Romiti, of Pisa; and Prof. Minot, of Harvard. The congress owes its successful initiation largely to Prof. Nicolas, of the University of Nancy, to whom inquiries may be addressed.

ON June 1 the Prince of Wales paid a private visit to the Cotton Exhibition at the Imperial Institute, which is being held by the Board of Trade in conjunction with the British Cotton-growing Association. The exhibition, which has been arranged by the scientific staff of the Imperial Institute under the direction of Prof. Wyndham Dunstan, F.R.S., in consultation with Sir Alfred Bateman and Sir Cecil Clementi-Smith, the managing committee of the institute, is intended to show not only the progress of cotton cultivation on British soil, but also to indicate the stages in the conversion of the raw material into the manufactured fabric. Bulk samples of commercial cottons grown in different parts of the Empire are supplemented with small specimens arranged to show the length of staple, and are accompanied by photographs of cotton fields, ginneries, &c., and statistical diagrams and maps. The British Cotton-growing Association, in addition to their raw cottons, exhibit a unique collection of native textiles. The machinery section includes models of Arkwright's machines, a power-loom in operation, and several testing machines. Manufacturing processes are illustrated by specimens and explained by means of diagrams, and samples of goods produced by special processes, including the making of "selvyt," are on view.

THE weather report issued by the Meteorological Office for the week ended on June 3 showed that the rainfall since the beginning of the year had only exceeded the average in the north of Scotland (excess 5·4 inches) and in the north of Ireland (excess 0·8 inch). The greatest deficiency was in north-east England (3·2 inches) and in the midland and southern counties (2 to 2·6 inches). The heavy downpours in the early part of this week will have contributed something towards making up the deficiency, especially in the eastern and southern parts of the kingdom. The *Daily Weather Report* of Monday last showed a great change in the distribution of barometric pressure, there being a steady increase over the northern and north-western districts, and a shallow depression having formed over France. During the twenty-four hours ending at 8h. a.m. on Tuesday, the rainfall was continuous and heavy over the south and south-east of England, amounting to nearly 2 inches at Dungeness, 1·5 inches at Clacton-on-Sea, and to an inch in London, the rain still continuing, practically without cessation, during the whole of Tuesday. The heaviest falls reported for the twenty-four hours ending 8h. a.m. on Wednesday were 0.57 inch in London and nearly half an inch at Oxford and Bath.

THE *Engineering and Mining Journal* records that payable ore has been reached at the New Chum Railway Mine, at Bendigo, Victoria, at a depth of 4262 feet. This is the greatest depth at which gold mining has been carried on. It has, however, been exceeded at the Lake Superior copper mines.

THE plans have been completed for the fifteen-story building, to cost 195,000*l.*, which Mr. Andrew Carnegie is to present to the engineering societies of New York. Adjoining it in the rear will be a thirteen-story house for the Engineers' Club, which is to cost an additional 75,000*l.*, and is also part of Mr. Carnegie's gift.

IN the *Engineer* there is a long and interesting description of the instructive case of models showing the construction of the leading types of expansion and plain slide-valves lately placed on view in the Victoria and Albert Museum. The collection forms a complete record of the progress made in this important branch of steam engineering.

IT is reported in *Engineering* that the world's copper production in 1904 amounted to 613,125 tons, the United States furnishing more than half the total. Great things in the way of copper production are expected from Alaska, where development is being carried on rapidly, especially in Tanana County. In the same journal, attention is directed to an important discovery of tin ore in the Vlaglaagte district of the Transvaal. The world's sources of tin supply are so few that interest must always attach to reported new finds.

WE have received a copy of a paper reprinted from the *Transactions of the Institution of Mining Engineers*, read on January 10, by Mr. James Ashworth, on outbursts of gas and coal at the Morrissey collieries, in the Crow's Nest Pass Coalfield, British Columbia. A huge outburst on November 18, 1904, caused the death of fourteen miners, and it is estimated that some 3,000,000 cubic feet of gas, at atmospheric pressure, were set free by the outburst in thirty-five minutes. Mr. Ashworth suggests that these unusually large outbursts may have some connection with the petroleum occurring in the district.

AT the forty-second general meeting of the Institution of Mining Engineers, held in London on June 2 and 3, several interesting papers were read. Mr. T. Y. Greener dealt with the firing of boilers by waste heat from coke ovens. Mr. M. R. Kirby described the compound winding engine at Lumpsey iron mine. Its steam consumption is only 38 lb. to 40 lb. per indicated horse-power hour. Mr. F. Hird gave the results of tests of the electric winding engine at Friedrichshall, and Mr. E. Lozé described electric winding engines installed at French collieries. Mining

education in the United States was discussed by Prof. H. Eckfeldt, and in New Zealand by Prof. J. Park. Coal mining in India was dealt with by Mr. T. Adamson. Mr. J. Jeffries described the occurrence of underground fires at the Greta colliery, New South Wales. Mr. W. C Blackett and Mr. R. G. Ware described a striking innovation in mining practice, the use of electrically driven mechanical conveyors for filling at the coal-face. Two years' experience has shown a saving of 48 per cent. over the ordinary pick and shovel method. Lastly, Mr. A. R. Sawyer gave an account of the geology of Chunies Poort, Zoutpansberg, Transvaal. Incidentally, he mentioned some old copper workings where native copper occurs in some abundance in dolomite. The proceedings terminated with a vote of thanks, proposed by Mr. Bennett H. Brough, to the Geological Society and to the Royal Astronomical Society for the use of their rooms for the meeting.

IN the *Biologisches Centralblatt* of May 15 Dr. O. Zacharias brings to a conclusion his article on the relations of modern hydrobiology to fish culture and fisheries. Dr. G. Schneider also discusses the origin of species among cestode worms. He concludes that morphological variation in union with biological isolation through parasitism are insufficient to form species unless aided by physiological, that is, sexual, isolation.

IN the *Nouveaux Mémoires* of the Moscow Academy, vol. xvi., parts ii. and iv., the well known Russian ornithologist, Dr. P. Suschkin, commences an important work on the osteology of the avian skeleton, the second part, which is alone before us, dealing with the osteology and classification of the diurnal birds of prey (Accipitres). This part is illustrated with four plates of various parts of the skeleton.

DURING a recent visit to the Victoria Falls of the Zambezi, Mr. W. L. Sclater, director of the South African Museum, obtained three fishes from that river which were sent to the British Museum for examination. One of these proved to be new, and is described by Mr. G. A. Boulenger in vol. iii., part vii., of the *Annals of the South African Museum* under the name of *Paratilapia carlottae* The genus is widely spread.

WE have received from the author, Mr. C. C. Hurst, a copy of his paper on experimental studies on heredity in rabbits, published in vol. xxix. of the *Journal of the Linnean Society*. The experiments were commenced in 1902, with the object of ascertaining whether the Mendelian principles of heredity were applicable to animals as well as plants, the animals selected being the white Angora rabbit and the Belgian hare. The results confirm, and extend to rabbits, those already obtained by Prof. Cuénot in the case of mice, though it would appear that the heredity of Dutch markings in rabbits differs in some respects from that of the "panachure" in mice.

IN the *Zoologist* for May, Mr. J. H. Gurney records the early history of a young cuckoo. On May 22 last year a hedge-sparrow's nest was found containing three eggs laid by the owner, and one egg deposited by a cuckoo. The cuckoo's egg was of the ordinary brown type, presenting no resemblance to the hedge-sparrow's eggs. On June 2 the young cuckoo and two hedge-sparrows were hatched, the third young hedge-sparrow, which had been hatched earlier, having previously disappeared. The next day the two nestling hedge-sparrows were found lying dead outside the nest. When one was replaced, no attempt was made to eject it by the cuckoo. The same result happened when a young wagtail was put into the nest; but when this was replaced by a young wren, the latter was ejected under the eyes of the observer in the usual manner. On June 22 the young cuckoo left the nest.

IN discussing certain habits of British bats in the eighth article of vol. xlix. of the *Memoirs of the Manchester Literary and Philosophical Society*, Mr. C. Oldham refers in the first place to the winter sleep, and points out that, from observations made in the disused copper mines of Alderley Edge, in the case of the long-eared bat this sleep is interrupted, the bats probably feeding at intervals on the insects which abound in the tunnels in winter, even if they do not venture forth into the open. The same is probably true of Daubenton's bat, the whiskered bat, and the lesser horse-shoe bat. There appears to be nothing to show that the bats occasionally seen abroad on mild days in winter are pipistrelles. Two popular fallacies are contradicted, firstly, that bats cannot walk, or can only shuffle awkwardly, along a flat surface, and secondly, that they cannot take flight from such a surface. The different

FIG. 1.—Lesser Horseshoe Bat in Repose.

postures assumed by British bats in repose form the subject of the plate illustrating Mr. Oldham's paper. The lesser horse-shoe bat, of which one of the figures is reproduced, recalls the posture assumed by the fox-bats, or flying-foxes, when at rest. The posture of ordinary bats is quite different, and it is a curious fact that while the lesser horse-shoe alights from the air in an inverted position, other bats, on first coming to rest, do so with the head upwards, and then reverse their position.

THE foregoing paper is supplemented by the observations of Mr. C. B. Moffat on the duration of flight among bats, published in the May number of the *Irish Naturalist*. In this communication it is shown that while the long-eared bat and the pipistrelle are all-night fliers, the hairy-armed bat only ventures forth for a short flight in the evening, and again shortly before dawn. The hairy-armed bat thus enjoys a daily rest of 21½ hours, taking all its exercise and its food in two periods (which in summer may be very close together) of one and a quarter hours each. There is a suggestion that the great bat, or noctule, indulges only in an evening flight, but additional evidence is required before this can be definitely accepted, and it appears to be contradicted by certain observations which the author did not see soon enough to incorporate in his text.

No. 1402 (vol. xxviii.), pp. 425–460, of the *Proceedings of the U.S. National Museum* contains descriptions by Mr. E. A. Mearns of new mammals from the Philippine Islands. The most interesting of these is a new genus of insectivore represented by *Podogymnura truei*. It is allied to Gymnura and Hylomys, and has a long hind-foot and a stout tail rather more than a third the length of head and body. Two tupaias are likewise referred to a new genus, Urogale, one of these having been previously described by Mr. O. Thomas as *Tupaia everetti*. They are characterised by the round tail. Several new genera of rats are likewise described, for one of which the author proposes the name Bullimus, a term, in our opinion, too like the familiar Bulimus. In vol. i., No. 6, of the *Bulletin of the Brooklyn Institute*, Dr. J. A. Allen describes a collection of mammals from Beaver County, Utah. Copies of three other American papers have been received during the current week. In the first, *Bulletin of the Brooklyn Institute*, vol. i., No. 6, Mr. C. Schaeffer records additions to the beetle fauna of the United States, with notes on some previously known species. In the second, *Proceedings of the U.S. National Museum*, No. 1400, Miss Richardson describes two new isopod crustaceans from California. In the third, *op. cit.* No. 1401, Mr. T. W. Vaughan gives a critical review of the genera of the fungoid corals, with a tentative classification.

When the "Book of Antelopes" was concluded in 1900 the authors were unable to give any satisfactory account of Heuglin's "giant eland" of the Bahr-el-Ghazal from the want of accessible specimens. Heuglin had described it in 1863, but had based his description on a single pair of horns, and Schweinfurth, who had subsequently met with the same animal in Bongoland, had given very little further information about it except that it had stripes on its body. In these circumstances Messrs. Sclater and Thomas classed the giant eland of Central Africa as a subspecies of the common eland (*Taurotragus oryx*) under the name *Taurotragus oryx gigas* ("Book of Antelopes," iv., p. 208). This splendid animal, which may be fairly called "the grandest of all the African antelopes," has lately been re-discovered by Mr. A. L. Butler, the superintendent of game preservation in the Anglo-Egyptian Sudan, who communicated a full description of it to the Zoological Society at a recent meeting. It appears, from the evidence given by Mr. Butler, that its nearest ally is the Derbian eland (*Taurotragus derbianus*) of Senegal, and not the typical *T. oryx*, and he therefore proposes to call it *Taurotragus derbianus gigas* instead of *T. oryx gigas*. This is probably correct, as the description given by Mr. Butler agrees very fairly in most points with the Derbian eland. But the giant eland appears to be a still larger and finer animal, with much stronger horns; its height at the withers is stated to be 68 inches. On this question we may shortly have an opportunity of forming an opinion, as Bimbashi Collins, of the Egyptian Army, who has himself shot two specimens of the animal, has sent the heads and skins to Mr. Butler to be forwarded to England, where they will probably go to the Natural History Museum at South Kensington.

The question of the sleep of fishes was referred to (p. 104) last week in our notice of the last volume of the "Cambridge Natural History." Mr. F. Davis, writing from 49 and 51 Imperial Buildings, Ludgate Circus, E.C., says that observations of many varieties kept by him in aquaria extending over a period of twenty years show that fishes do sleep. He has also observed what appeared to be the play or sports of fishes, which probably serves the same biological ends as in the higher vertebrates. He remarks:—"Apparently when kept in aquaria fishes only sleep during the hours of darkness. If an artificial light be thrown upon them they quickly regain consciousness."

We have received the annual report for 1903 of the Government bacteriologist and director of the laboratory (Mr. H. Watkins-Pitchford), Pietermaritzburg, showing that much good work is being done in the colony. It contains a valuable bacteriological report on the plague in Natal in 1902–3.

The "Nervous Diseases Research Fund" has just issued its first annual report. The object of the fund is to promote and carry on research into the origin and cure of diseases of the nervous system. The work is carried on at the National Hospital, Queen's Square, W.C., and is under the direct supervision of the medical staff of the hospital. During 1904, forty-eight autopsies were performed and the pathological condition investigated. Special attention has been directed to the study of a disease known as myasthenia gravis, which is almost invariably fatal, and about which little is known at present.

The development of lenticels at points where the stress is small is discussed by Mr. J. A. Terras in an article in the *Transactions and Proceedings of the Botanical Society of Edinburgh* (vol. xxii., part iv.), and the origin of lenticels on roots is described in some detail. A first account of new species of flowering plants from the Republic of Colombia, mostly collected by the writer, who accompanied Captain Dowding's expedition in 1898–9, is contributed by Mr. T. A. Sprague to the same number.

A recent leaflet issued by the Board of Agriculture and Fisheries furnishes an account of the life-history of the pine sawfly, *Lophyrus pini*, which attacks more especially the Scots pine and the black Austrian pine. Two broods develop in the year, the first in May and the second in August. The larvæ are the source of damage, as they devour the pine needles. Amongst the animals which feed on the larvæ are mice, squirrels, goatsuckers, and starlings, also numerous ichneumon flies. In plantations the best remedy is to kill the larvæ by hand, but as a spray for ornamental trees in parks and gardens, hellebore essence or arsenate of lead is recommended.

Although the investigation of the gametophytes and embryo of the gymnospermous genus Torreya has not yielded the critical results which had been expected, several interesting taxonomic characters were observed by Dr. J. M. Coulter and Mr. W. J. G. Land, and are described in their account of *Torreya taxifolia* in the *Botanical Gazette* (March). The archegonium initial is differentiated very early, while most of the endosperm develops after fertilisation. A pro-embryo of twelve to eighteen cells completely fills the egg and persists through the winter, until in the spring the suspensor elongates, and later the ruminated appearance of the endosperm becomes apparent. Rumination is shown to be due to the unequal resistance offered by the perisperm in different parts of the seed to the encroaching endosperm.

The report of the Meteorological Commission of Cape Colony for the half-year ending June 30, 1904, has been received. The usual tables of rainfall, temperature, &c., at various stations will not be published until the issue of the next half-yearly report, so that the data may be comparable with the information contained in previous yearly reports. But in lieu of the usual tables above referred to,

the present issue contains a very valuable series of twenty-three tables prepared by the secretary (Mr. C. M. Stewart) showing the characteristic features of the winds at the Cape Observatory during the five years 1896–1900, arranged under sixteen points of the compass, and referred to various elements, *e.g.* temperature, humidity, &c., and giving the percentage of relative wind-frequency and wind-force at various hours.

WE have received a copy of the report of the director of the Philippine Weather Bureau for the year ending August 31, 1904 (reprinted from the report of the Philippine Commission, part ii.). We have frequently had occasion to refer to the useful work of this organisation, and the valuable researches and publications of the Rev. J. Algué, S.J., particularly in respect of the cyclones in the Far East. The central office performs a large amount of work gratuitously for observers on land and sea, by adjusting and comparing instruments; this is generally only known to those benefited. The director states that the weather bureau is never closed; the chief officials live at the observatory, and are ready to attend any call at all hours, especially inquiries by officers of ships, if they wish for information as to the conditions of weather. In addition to the regular work, telegrams are constantly exchanged between the provinces, China, Formosa, and Japan, and when bad weather is impending special warnings are dispatched to the points threatened.

THE annual summary of the Monthly Weather Review of the U.S. Weather Bureau for 1904, containing a useful subject, author, and title index of the papers published in the monthly parts, and an annual climatological summary of the observations made at the Weather Bureau stations, has just reached us. Weather forecasts for thirty-six and forty-eight hours in advance have been made daily throughout the year for each State, and special warnings of gales on the sea coasts have been issued when necessary. In a number of instances, the chief of the Weather Bureau states, European shipping interests were notified of the character and probable course of severe storms that were passing eastward from the American coast. The warnings and indications of the movements of West India hurricanes have evidently been the means of saving a large amount of property and a number of lives, and their value has been acknowledged by the Press, and also by the President of the Jacksonville Board of Trade, who states that the warnings to vessels not to leave port prevented serious disasters. Prof. W. L. Moore expresses the hope that the time will come when it will be possible to forecast the weather generally for coming seasons, but that time has not yet arrived. Valuable researches are being made at Mount Weather Observatory, Virginia, where it is proposed, *inter alia*, to discuss meteorological observations from the point of view of their relations to solar physics, and to select meteorological and magnetic elements and compare them with solar observations.

IN the current number of the *Comptes rendus* of the Paris Academy of Sciences M. Guyou gives an interesting account of the utilisation of the telephone system for the exact transmission of time. The experiments were undertaken by the Observatory of the Bureau des Longitudes at the request of the Chambre syndicale de l'Horlogerie, and after a preliminary trial in the Paris area were extended to the whole French system. The transmission of the time by a verbal signal not being sufficiently exact for the purpose, by means of a specially arranged microphone each beat of the pendulum of the standard clock in the observatory could be heard in the telephone receiver, the operator at the sending end merely counting one or two beats. On May 25 the destroyer *Escopette*, whilst at Brest, was able to regulate its chronometers directly against the standard clock of the Observatory of Montsouris with an accuracy of about 0·1 to 0·2 second. As M. Guyou points out, owing to the wide extent of the telephone system at the present time, this mode of transmitting the time ought to be of considerable service.

IN *Kungl. Svenska Vetensk. Akad. Handl.* (Band 38, No. 5) Dr. Hasselberg gives the results of an investigation of the arc spectrum of tungsten. The region he has studied extends from λ 3477 to λ 5892. This is a continuation of the very useful series of publications by the same spectroscopist relating to the arc spectra of metals. The elimination of lines due to impurities was done by comparing the tungsten spectrum with those of other metals taken under similar conditions. In cases of close agreement between tungsten lines and those of other metals a special study was made of the lines with the object of establishing their coincidence or non-coincidence, and in the former case the probable origin of the common line was determined from a consideration of the relative intensities in the two spectra. In a comparison column are given the lines recorded by Messrs. Exner and Haschek for the same element. The strongest lines of this metal have been carefully compared with the Fraunhoferic lines, and cases of coincidence and probable identity noted.

IN our issue of July 28, 1904, we noted that Dr. H. M. Reese, of Yerkes Observatory, had published the results of some observations of "enhanced" lines in the Fe, Ti, and Ni spectra, wherein he supposed that he had discovered some enhanced lines not included in Sir Norman Lockyer's lists. In the current number of the *Astrophysical Journal* Mr. F. E. Baxandall comments on Dr. Reese's results, and shows that in a great number of cases there is no evidence of enhancement in the Kensington photographs. For example, the comparative tables given show for each element that of the seventy enhanced lines discovered by Dr. Reese for iron, fifteen are actually stronger in the arc than in the spark spectrum, twenty-five are equally strong in both spectra, twenty do not occur in either spectra on the Kensington grating spectrograms, whilst six are so slightly "enhanced" as to leave it doubtful as to whether they should be included in this category. It seems probable that Dr. Reese was misled by comparing two spectra of which the spark was generally the stronger, for he especially remarked that only one line was stronger in his arc than in his spark spectrum.

WE have received from the Bureau of Mines of Ontario an interesting memoir on the limestones of the province by Mr. Willet G. Miller, the provincial geologist. It covers 143 pages, and contains a number of excellent photographs of the principal quarries. It shows clearly where limestones of various chemical compositions are to be found, and gives a concise account of the uses of limestone and lime at the present time. Hitherto it has hardly been realised that limestones form an important part of the mineral resources of Ontario, and this well arranged collection of analyses of limestone and of descriptions of quarries cannot fail to prove of value to all interested in the important industries that depend upon limestone as a base.

MESSRS. ILIFFE AND SONS, LTD., have published a little book on practical frame-making by Colonel W. L. Noverre; the price is 1s. net.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHIC REALITY OF THE MARTIAN CANALS.—No. 4021 of the *Astronomische Nachrichten* contains a telegram dated May 28 from Mr. Lowell to Prof. Pickering in which the former states that several of the canals on Mars have been photographed by Mr. Lampland. Amongst others, Nilo Syrtis, Casius, Vexillum, Thoth, Cerberus, Helicon, Styx, Chaos, and Liedeus (? Libneus) are shown on the negatives, some appearing on more than twenty plates.

DISCOVERY OF SATURN'S TENTH SATELLITE.—A brief note in No. 4015 of the *Astronomische Nachrichten* states that Saturn's tenth satellite was discovered from an examination of several plates taken with the 24-inch Bruce telescope which were selected from those used in the determination of the orbit of Phœbe.

The new satellite appears on thirteen plates. The orbital motion is direct and the period is twenty-one days, therefore the satellite is apparently a little nearer to Saturn than is Hyperion.

JUPITER'S SIXTH AND SEVENTH SATELLITES.—An abstract from vol. xvii. of the *Publications of the Astronomical Society of the Pacific*, appearing in No. 4015 of the *Astronomische Nachrichten*, contains an account by Prof. Perrine of the observations so far made of Jupiter's sixth and seventh satellites.

The former can be photographed in ten minutes with the Crossley reflector, and thirty-six plates have been obtained. A preliminary investigation of the orbit shows that the inclination to the ecliptic and the planet's equator is about 30°, and that the satellite has a period of about 250 days, with a mean distance from the planet of 7,000,000 miles. The direction of the orbital motion still remains uncertain. The brightness of the satellite indicates a diameter of about 100 miles, or less.

On examining the plates taken for the sixth satellite on January 2, 3, and 4, a much fainter object, also apparently belonging to Jupiter, was discovered, which was then situated N. and W. of, and was moving towards, the planet. Subsequent observations, which, owing to the satellite's faintness, were much more difficult to make than in the case of the sixth satellite, confirmed its dependence upon Jupiter. This object was not shown on the negatives taken for the sixth satellite during December, being just outside their field, but altogether twenty observations have been made, the last on March 9.

Apparently the orbit of the seventh satellite is quite eccentric, with a mean distance from the planet of about 6,000,000 miles and a period of about 200 days. The inclination of the orbit to the plane of Jupiter's equator is about 30°, but the direction of the orbital motion is as yet undetermined. The photographic magnitude of the seventh satellite is not brighter than the sixteenth, and on comparing this with the magnitudes of other satellites and of asteroids a diameter of about 35 miles is deduced.

Prof. Perrine suggests that the large inclination of their orbits indicates that neither of these bodies were originally members of Jupiter's family, but have been "captured" by the planet.

STARS WITH SPECTRA OF THE ORION TYPE.—In No. 2, vol. lvi., of the *Annals of the Harvard College Observatory*, the distribution of stars having class B or Orion-type spectra is discussed, and all known stars of this type placed in a catalogue, in order of R.A., the position (1900·0), magnitude, exact type of spectrum, and the galactic longitude and latitude being given for each star. Considerably more than 30,000 spectra have been examined by Mrs. Fleming in connection with the Henry Draper memorial work, and of these 803 are included in the present catalogue.

As a distinctive feature of these stars is the helium indicated in their spectra, the allocation of them with regard to galactic longitude and latitude really indicates the distribution of helium in the universe. On thus classifying them, it is found that on dividing the sky into equal areas the galactic latitudes of which are included between +90° and +30°, +30° and 0°, 0° and −30°, and −30° and −90°, the numbers of well marked helium stars in these divisions are 22, 219, 509, and 53, or 3, 27, 63, and 7 per cent. of the total respectively, nine-tenths of them being within 30° of the galactic equator. A congregation in certain galactic longitudes is also indicated. Thus between 160° and 340° there are 613, or 78 per cent. of the total, of these stars. About one-quarter of the whole number are contained in four regions having a total area of 790 square degrees, or less than one-fiftieth of the sky. One of these four regions is near to the variable star η Carinæ, and lies almost wholly within the constellation Argus. As this Argus region contains nearly three times as many "Orion" stars as does the Orion region, Prof. Pickering suggests that "Argus" stars would have been a more suitable generic name for the class of stars having spectra of this (B) type. He states, however, that the nebula of Orion appears to be the starting point, or origin, of class B stars, twenty of which are situated within 1° of θ Orionis, that is to say, nearly as many as are contained in the region between galactic latitudes +30° and +90°, although the area of the latter region is three thousand times as great.

Arranging them according to magnitude, it is found that most of this class are bright stars, only 1 in 20 being of the sixth or fainter magnitudes.

THE MOTION OF THE TAIL OF BORRELLY'S COMET (1903 iv).—From the examination of a number of photographs obtained by different observers during July, 1903, Prof. Jaegermann, Moscow, has compared the relative motions of the different sections of the tail of comet 1903 iv in regard to the movements of the comet's nucleus and to the sun. After analysing the velocities and movements determined, he has arrived at the conclusion that in this case light-pressure, acting in the sense of Arrhenius's hypothesis, was not the determining factor in the formation of the several tails, for a pressure sixty times greater than gravity would have to be assumed. If the light-pressure hypothesis be retained, the assumption must be made, according to Bredichin's idea, that the tail-matter consisted of gaseous molecules, and that its illumination was due to the fluorescence of highly illuminated gases, such as has been experimentally demonstrated by Lommel, Wiedemann, and Schmidt.

The existence of a repulsive force, other than light-pressure, was demonstrated by Bredichin in comet Rordame (1893 ii), by Prof. W. H. Pickering in comet Swift, and was confirmed by Prof. Jaegermann in a preliminary investigation concerning the denser parts of the tail of comet Swift, 1892 i.

DOUBLE STAR OBSERVATIONS.—The results of a series of observations of double stars made at Kirkwood (Indiana) Observatory are given in No. 4022 of the *Astronomische Nachrichten*. The observations were made by Mr. J. A. Miller and Prof. W. A. Cogshall with a 12-inch refractor, and the B.D. and A.G. numbers, the 1875 position, the magnitudes, and the measured position-angle and distance are given for each of 114 double stars.

The objects observed were selected from those noted as double by the Leipzig observers when preparing the A.G. catalogue for the zone +10° to +15°, and, with few exceptions, they have not been measured elsewhere. Some few stars suspected by the Leipzig observers as duplicate could not be seen as such by the Kirkwood observers, and one or two of the sets of measures refer to newly discovered double stars.

THE ROYAL OBSERVATORY, GREENWICH.

ON Saturday last, June 3, the Board of Visitors made their annual inspection of the Royal Observatory, Greenwich, but unfortunately, through ill-health, the Astronomer Royal was not able to be present. The following is a brief abstract of the report which was submitted to the visitors.

Very great progress has been made in the observation of the reference stars for the Greenwich section of the Astrographic Catalogue, about 9500 observations of R.A. and N.P.D. having been added during the year. The comparatively few observations required to secure five observations of each of the reference stars (more than 10,000 in number) will easily be obtained by the end of the year, as there are only 5 stars requiring three observ-

ations, 100 requiring two, and 1500 requiring one observation only in order to carry out the programme. In fact, it may be taken that the observations for this catalogue are practically completed. The catalogue, which will be terminated this year, will contain, besides the reference stars for the Astrographic Catalogue, the 834 zodiacal stars given in the Nautical Almanac for 1897.

It is proposed to begin next year a new nine-year catalogue of the stars of magnitude 9·0 and brighter between the limits +24° to +32° of N. declination, this being the Oxford astrographic zone, for which they serve as reference stars. The re-observation of these stars, which for the most part fall within the Cambridge zone of the Astronomische Gesellschaft Catalogue, will afford valuable data for their proper motions, besides giving fundamental positions for the Oxford astrographic plates.

The comparison between theory and the Greenwich meridian observations of the moon from 1750 to the present time, undertaken by Mr. Cowell, has been completed for the longitudes, and the discussion from 1847 to 1901 is completed for the latitudes. The only point left outstanding is the motion of the node, for which it is necessary to discuss as long a series of observations as possible. The results obtained for the longitudes are summarised in a series of papers in the *Monthly Notices of the Royal Astronomical Society*. In particular, the paper in vol. lxv., No. 2 (1904 December), gives the coefficients of 145 terms as obtained directly from observation, with a comparison with the theoretical coefficients given by Hansen, Delaunay, M. Radau, and Dr. Hill. The publication of the details of the whole investigation will be shortly proceeded with.

The re-reduction of Groombridge's observations was completed at the date of the last report, and during this year the printing of the results has been pushed on. The introduction has also been prepared for press. A discussion of the proper motions determined by comparison with modern Greenwich observations, and a determination of the constant of precession and of the direction of the solar motion by Mr. Dyson and Mr. Thackeray, are given in the *Monthly Notices of the Royal Astronomical Society*, March.

The altazimuth has been in regular use throughout the year, and a second determination of the pivot errors has been made, and also observations for obtaining the value of one revolution and errors of the screw of the telescope-micrometer have been completed.

The observations of the moon, both in and out of the meridian, seem very satisfactory as shown by the agreement between the two instruments, the transit circle and the altazimuth.

The 28-inch refractor has been employed, as was the case last year, for micrometric measurements of double stars, the total number measured being 603. Of these, 143 have their components less than $1''\cdot0$ apart, and 60 less than $0''\cdot5$. A marked deterioration of the images of the stars led to an examination of the lenses, and the suspected tilt between the components was corroborated and remedied.

Sixty-five photographs of Neptune and its satellite have been secured with the 26-inch refractor, while, with the 30-inch reflector, numerous photographs of minor planets and comets *a*, *b*, *c* 1904, and *a* 1905, have been obtained.

At the date of the last report, 119 plates taken of Eros with the astrographic equatorial, and 55 taken with the Thompson equatorial, had been measured. During this year the remainder of the photographs have been measured, making in all 198 with the astrographic equatorial and 152 with the Thompson instrument. The reduction of the measures is in a satisfactory state, and it is expected that it will be completed in two months for both sets of photographs.

The astrographic equatorial has been employed mainly to obtain photographs to replace chart plates which show slight photographic defects unsuitable for production of enlarged prints.

The measurement of the catalogue plates for the Greenwich section is now completed. Since the last report 47,200 measures of pairs of images (6m. and 3m.) have been made. The number of plates measured in the year is 102, covering 128 square degrees between declination 83° and the pole. The number of plates measured up to the date of last year's report was 1051. Adding the 102 plates measured this year, the total number of plates measured is 1153, being the 1149 of the Greenwich section + 4 additional photographs of the polar field.

For the year ending 1904 December 31, Greenwich photographs of the sun have been selected for measurement on 209 days, and photographs from India and Mauritius (to fill up the gaps in the series) on 151 days, making a total of 360 days out of 366 on which photographs are at present available. Photographs were taken in Mauritius for three of the six days yet unrepresented, and may be received in due course.

The solar activity has shown a great increase during the year ending 1905 May 10, and the sun has not been free from spots on a single day during that period. The mean daily spotted area for 1904 was more than half as great again as that for 1903, and early in the present year a number of exceptionally large groups was observed. The group which was seen first on the east limb on 1905 January 28 had a greater total area than any other group which has been photographed at the Royal Observatory.

The principal results of the magnetic elements for 1904 are as follows:—

Mean declination	16° 15'·0 West.
Mean horizontal force	4·0166 (in British Units). 1·8520 (in Metric Units).
Mean dip (with 3 needles) ...	66° 57' 11".

In 1904 there were no days of great magnetic disturbance and eight of lesser disturbance.

The mean temperature for the year 1904 was 49°·8, or 0°·3 above the average for the fifty years 1841–90. During the twelve months ending 1905 April 30 the highest temperature in the shade (recorded on the open stand in the magnetic pavilion enclosure) was 91°·0, on August 4. On the same day the highest temperature in the Stevenson screen in the magnetic pavilion enclosure was 89°·5, and in the observatory grounds 89°·7. The lowest temperature of the air recorded in the year was 19°·5, on January 1. During the winter there were thirty-nine days on which the temperature fell below 32°·0, being seventeen less than the average number.

The mean daily horizontal movement of the air in the year ending 1905 April 30 was 280 miles, which is 2 miles below the average of the preceding thirty-seven years. The greatest recorded daily movement was 867 miles, on November 9, and the least 49 miles, on December 22. The greatest recorded pressure of the wind was 23·5 lb. on the square foot, on March 12, and the greatest hourly velocity 45 miles, on December 30.

The number of hours of bright sunshine recorded during the twelve months ending 1905 April 30, by the Campbell-Stokes instrument, was 1486 out of 4457 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·333, constant sunshine being represented by 1.

The rainfall for the year ending 1905 April 30 was 20·21 inches, being 4·33 inches less than the average of the fifty years 1841–90. The number of rainy days was 153. This small rainfall may be contrasted with the heavy rainfall of 35·42 inches in the corresponding period last year. The most striking contrast is obtained by comparing the rainfall for the year commencing 1903 March 1, which was more than 37 inches, with that for the year commencing 1904 March 1, which was less than 17½ inches. This dry period of twelve months was followed by a heavy rainfall in 1905 March, which exceeded 3½ inches, and is the greatest amount recorded in March since 1851.

The printing of the Paris-Greenwich longitude determination, 1902, is practically complete. The Killorglin longitude is the only determination which still requires to be printed to complete the volume of longitude determinations, which will contain the determinations Paris-Greenwich made in 1888, 1892, and 1902, of Greenwich-Waterville-Canso-Montreal made in 1892, and of Greenwich-Killorglin made in 1898.

The re-reduced Groombridge Catalogue is nearly completely printed, with the exception of the introduction, which is ready for the press.

Provision has been made in the Navy Estimates for the observation of the total solar eclipse of 1905 August 30 by a party of three observers on the coast of Tunis, where the weather conditions are promising. It is proposed to take photographs of the corona for detail and extension with the Thompson 9-inch coronagraph, the 13-inch astrographic refractor, and the 4-inch Dallmeyer rapid rectilinear lens, and also photographs of the spectrum with the two spectroscopes lent by Major Hills, R.E., as in 1900 and 1901.

THE OPTICAL CONVENTION.

THE optical convention has just concluded a very successful meeting extending over four days; the exhibition and the papers attracted numerous visitors from all parts of the country. The papers led to much valuable discussion. An account of the exhibition and the president's address appeared in last week's NATURE.

The first group of papers dealt with the design of optical and scientific instruments. The Gauss theory was entrusted to Mr. Conrad Beck, who considered the theory of the equivalent planes of complete optical instruments; he dealt more particularly with the complete microscope in relation to its "working distance."

Dr. Drysdale gave a general account of the aberrations of lens systems, submitting a classification and specification of the various aberrations to obtain an expression of opinion from those working at the subject. Mr. Chalmers gave a graphical method of representing the results of calculations of lens systems, and a modification of the Hartmann system of testing to permit of measuring and expressing aberrations in exactly the same form. This should make it possible to obtain the relation between the definition and the measured or calculated aberrations. In the discussion Mr. Carson pointed out the importance of the relative intensity of the image disc and the aberration patch in estimating the performance of lenses.

Mr. Walter Rosenhain criticised the mechanical design of certain types of instruments; he showed that, in many cases, the ideals of the instrument maker were in conflict with sound engineering principles, and suggested directions in which improvements might be looked for.

Diffraction in optical instruments was discussed by Mr. J. W. Gordon in an important theoretical paper; his conclusions, which would modify many of our ideas on optical systems, are now being submitted to a definite experimental test.

A group of papers related to interference phenomena. Mr. J. Rheinberg exhibited a method of producing achromatic interference bands which is likely to have numerous applications. Mr. Stansfield described a simple form of Michelson interferometer specially suitable for demonstration. Prof. Watkin and Mr. Morrow exhibited their apparatus for calibrating extensometers by observing the displacement of interference bands.

Mr. Twyman described the manufacture of the Echelon spectroscope, stating the accuracy required in the plates and the precautions used to obtain it. This apparatus was exhibited and compared with the Lummer "parallel plate" arrangement for obtaining resolution of spectrum lines. Mr. Blakesley discussed the various forms of prism which could be used in constant deviation spectroscopes and some of their applications. Mr. Newall dealt with astronomical spectroscopes, demonstrating that the limits of usefulness of the present type of spectroscope were almost reached in the case of faint stars, as the intensity of light necessary for photographing their spectra can only be obtained at the sacrifice of the purity of the spectrum or the certainty of identification of the lines, and that no very marked improvement is likely to be obtained from the use of larger objectives, on account of the increased absorption in the prisms required. He suggested the use of gratings.

Lord Rayleigh dealt with the subject of polish, pointing out the distinction between the process of grinding, which consists of the removal of comparatively large flakes, and that of polishing, which he regards as molecular, the roughnesses of the surface being reduced to dimensions smaller than the wave-length of light. Experiments on the thickness of glass removed by polishing and by etching with hydrofluoric acid under various conditions were illustrated. In the discussion Mr. Walter Rosenhain cited evidence to show that the surface flow which has been recognised in the polishing of metals also occurs in glass.

Mr. Walter Rosenhain dealt with the possibilities of progress in optical glass; he described the limitations to the production of vitreous fluxes of extreme properties, and advanced the view that media of widely different optical properties could only be obtained by the production of large homogeneous crystals. Physicochemical considerations were cited to indicate lines upon which this difficult problem might be solved.

A number of instruments for optical measurements were described, Prof. Poynting exhibiting his form of parallel plate micrometer. Mr. Blakesley described his apparatus for the measurement of focal length of lenses, with applications to other optical measurements. Mr. Chalmers described a new form of refractometer for obtaining the refractive index of glass in lens form. The lens is inserted in a trough containing a suitable transparent liquid, and the difference of the refractive indices is deduced from the approximate curvatures of the lens and its power in the liquid, with an accuracy comparable with that of the best refractometers.

Mr. Baugh described the use of invar tapes for base-line measurements.

Dr. Drysdale discussed the requirements of small telescopes and binoculars, with special reference to the field of view and illumination of the image. He indicated the method he had employed in calculations for prism binoculars, showing how he had been led to use glass of high refractive index for the prisms. He described a special form of photometer for determining the absorption in binoculars.

Mr. A. C. Jolley gave a critical review of photometric standards and apparatus; he described a modification of the Violle platinum standard, and discussed the difficult problems connected with heterochromatic photometry; his results indicate that the accuracy claimed by Sir W. Abney is far too high, especially when readings by different observers are compared. He concludes that a discrimination photometer is the most trustworthy instrument for comparing different colours.

Mr. Milne exhibited his new form of spectrophotometer. The apparatus is especially suitable for determinations of the absorption of light of specified wave-length by liquids.

Mr. Bull discussed the theory of tricolour filters, plates, and inks. He concluded that it was most satisfactory to adjust each independently of errors in the adjustment of the others. The filters should have a certain amount of overlap, the colour of the overlap of two filters being the colour of the printing ink corresponding to the other filter.

Mr. Crawley discussed the limits of stereoscopic vision; the results of his measurements point to a much greater accuracy in judging distances by stereoscopic effect than is generally admitted.

Mr. H. L. Taylor discussed the effects of astigmatism on the accommodation of the eye. Two new forms of ophthalmometer were demonstrated, one being the Ettles-Curties, which is valuable for the perfection of its mechanical adjustments, and the use of complementary colours for the mires; it is so arranged that the corneal microscope can be readily attached. The ophthalmometer shown by Mr. Sutcliffe contains a number of variations from ordinary forms; the mire is an almost complete ring illuminated by a special lamp, and the method of doubling the image is novel.

Dr. Walmsley gave an account of the attempts which have been made to provide technical education for those engaged in the optical industry, and the existing facilities; he outlined the scheme for the establishment of a British Institute of Technical Optics. The convention decided to memorialise the London County Council to support the scheme.

Major-General Waterhouse gave an account of the history of telephotography.

In the evening lecture, Prof. Silvanus P. Thompson gave a most interesting account of the various forms of Nicol's prism and its modern equivalents.

AGRICULTURAL NOTES.

THE annual report of the Transvaal Department of Agriculture for 1903–4 is a volume of more than 400 pages, which contains, in addition to an introduction by the director, reports on the fourteen sections into which the work of the department falls. In discussing the *personnel* of the department, the director refers to the difficulty of obtaining expert assistants, a difficulty which, so far as agriculture is concerned, exists in all countries supplied from Britain, and even in such countries as the United States, where the training of the expert receives more attention than it does here. Many of the chief positions in the Transvaal department have now been filled up, but assistants are still required, and as the work expands it is probable that a considerable number will be engaged. The report states that men for scientific work "will doubtless best be obtained from amongst students who have had good careers at one or other of the universities, and who have done a certain amount of research after taking their degree. A thorough grounding in pure science is a *sine qua non,* and if they are not acquainted with the applied side of Science, this knowledge will have to be acquired in our laboratories whilst acting as assistants to the Chief of their particular Division."

The above named report contains many interesting paragraphs. Here is one that appears under the heading "Farmers' Cooperative Experiment Reports":—From General Louis Botha, Pretoria, "They (mangels from England sent for trial by the Department) do not grow so quickly as other sorts of root-crops, but if sown early they will grow splendidly and give a good winter crop in May; therefore I ordered a big quantity which I intend to use this year."

In papers contributed to the first four parts of the *Agricultural Journal of the Cape of Good Hope* for the current year, Mr. D. E. Hutchins, conservator of forests at Cape Town, makes out a strong case for the extension of tree planting in South Africa. The coast districts have a very favourable climate, growth is rapid, and the quality of the timber produced is good; but while native resources have not been developed, timber to the value of 1½ millions is imported annually. There is no reason why most of the wood required for building and mining purposes should not be grown in the country, and it is estimated that every 1*l.* spent in afforesting suitable land would bring in an annual revenue of 1*l.* in thirty-five years' time! If Mr. Hutchins can convince the financier that this estimate is correct, South Africa should soon grow its own timber; but in this branch of agriculture the sower seldom reaps, and the investor is not easily convinced. It is likely, therefore, that in South Africa, as elsewhere, the lack of capital will prove a more serious difficulty to the enthusiastic forester than either soil or climate.

In a recent number of the *Bulletin of the College of Agriculture, Tokyo Imperial University,* there is an article of considerable interest to British agriculturists. The Japanese farmer, like the English farmer of half a century ago, is given to employing lime more freely than is good for his land, and in some districts the injury done by liming has caused the authorities to interfere with the practice. Following up some work by Kellner and Böttcher on the effects of lime on the action of certain phosphates, Nagaoka investigated the results of employing a number of phosphatic fertilisers on limed and on unlimed land. Rice was grown, and it was shown that lime greatly interfered with the action of those phosphatic manures which were of animal origin, such as bone meal or fish bones; on the other hand, when the phosphates were derived from a vegetable source, the effects of lime were not very pronounced. The injury was about twice as great in manures of animal as in those of vegetable origin. The injurious action of lime extended into a second year. Nagaoka's results confirm those obtained by Kellner and Böttcher in Germany, and indicate that such manures as bone meal and fish meal should not be used on recently limed soils.

We have received from the committee of the Lawes Agricultural Trust a copy of the report of the director, Mr. A. D. Hall, on the work done at the Rothamsted Experimental Station for the year ending March 31. The well known experimental fields are still continued without any essential change; in addition, a new field has been laid out to test the residual value of various manures in the second and succeeding years after their application. Other experiments deal with calcium cyanamide, the new manure containing nitrogen derived from the atmosphere, and with the various cultivations of bacteria which have been recently introduced for the inoculation of leguminous crops, with the view of making them more efficient collectors of atmospheric nitrogen. During the year in question seven papers have been issued from the station, all of which deal with investigations on the soil, methods of soil analysis, &c. The annual losses of carbonate of lime in the Rothamsted soil have been determined, both that due to natural agencies and that caused by the use of manures. Certain restorative actions have been investigated which account for the maintenance of the fertility of many soils which are almost devoid of lime. Another of the papers deals with the remarkable accumulations of fertility in certain plots of land which have been allowed to run wild for the last twenty years, and have in that time gained nitrogen to an extent not readily explicable by the accepted theories. The Lawes Trust committee continues to find its income very inadequate to the proper development of the station; only donations and subscriptions from various sources, including 300*l.* from the Goldsmiths' Company, 50*l.* from the Clothworkers' Company, 50*l.* from Lord Rothschild, &c., have prevented a serious deficit on the year's working. Mr. J. F. Mason has also promised to erect and equip a new laboratory for agricultural bacteriology, which will be the first of its kind in this country, as a continuance of the experiments carried on for many years by his father, the late Mr. James Mason, at Eynsham Hall, Oxon.

REPORTS ON SEA FISHERIES.

THE report for 1904 on the Lancashire Sea Fisheries Laboratory at the University of Liverpool and the sea fish hatchery at Piel[1] contains an introduction and general account of the year's work, written, as usual, by Prof. Herdman, the honorary director of the scientific work.

A report upon the sea fish hatchery at Piel, by Mr. Andrew Scott, shows that more than a million plaice fry and more than twelve million flounder fry were liberated, the result of hatching eggs laid by fish caught in the autumn and confined in tanks at the hatchery. The useful results to the fisheries of thus confining spawners and turning out the newly hatched fry have yet to be demonstrated.

A paper upon the tow-nettings collected in the Irish Sea, contributed by Mr. Scott, is of little value, because it is far too general, the contents of the tow-nets not having been identified. Such records as "Copepoda, medusoids, gelatinous algæ, a fish egg," are perhaps of some value, but of very little. It appears to us that had less been attempted, and some one group properly worked, the value of the paper would have been much greater. In referring to the occurrence of pelagic fish eggs, the scientific names of the various species might have been mentioned with advantage.

Bacteriological investigations in relation to shell-fish pollution by sewage matter, by Mr. James Johnstone, is an interesting paper continuing an investigation carried on during the previous year. Mr. Johnstone is also responsible for a paper upon plaice-marking experiments, and for another upon the internal parasites and diseased conditions of fishes. The plaice-marking experiments are upon a small scale, but no doubt will give results of interest in time. Dr. J. Travis Jenkins, recently appointed to the post of superintendent of fisheries of the district, contributes an interesting discussion of official fishery statistics, from which it appears that the Board of Trade returns are not always accurate. Dr. Jenkins's remarks

[1] Report or 1904 on the Lancashire Sea Fisheries Laboratory at University of Liverpool and the Sea-fish Hatchery at Piel; and Syllabu Lessons on Marine Biology. (Liverpool, 1905.

upon the cockle industry are both interesting and important.

The volume contains several plates and woodcuts, and is in paper covers. The education committee of the Lancashire County Council provided funds for the instruction of fishermen at the Piel hatchery, and forty-five fishermen attended the class which was held in the spring by Mr. James Johnstone. A "Syllabus of the Lessons in Marine Biology given in the Practical Classes for Fishermen" has been revised, and is now published as a separate volume. It is difficult to estimate the value to the fishermen of the benefit to be derived from a superficial knowledge of marine biology, but the value to the laboratory no doubt lies in the fact that the men send in specimens of animals and plants taken in the course of their fishing operations.

The Danish fishery and hydrographical contributions to the international North Sea fisheries investigations,[1] lately issued, include two papers dealing with fishery matters, one by Mr. Johs. Schmidt being concerned with the pelagic post-larval stages of the two species of halibut *Hippoglossus vulgaris*, Flem., and *H. hippoglossöides* (Walb.). Mr. Schmidt points out that the best distinction between these two species is not in the number of fin-rays, but in the number of vertebræ, and he found certain post-larval fishes off Iceland and the Færöe Islands which agreed in the number of vertebræ with the adults of *H. vulgaris*. The material from which he determined the young stages of *H. hippoglossöides* was taken by the Danish Ingolf Expedition.

The other fishery paper is by Dr. A. C. Johansen, and is entitled "Contributions to the Biology of the Plaice with Special Regard to the Danish Plaice Fishery," and is the first report published upon the subject. The paper is exceedingly interesting, the results, chiefly in regard to the growth and migrations of the plaice, having been obtained by recording the length of a number of fish, marking them with a label, and returning them to the sea to be caught later on by one of the numerous fishing boats. A fair percentage of the fish have been recovered, and by re-measuring these fish their rate of growth during the time between their marking and re-capture has been determined. An interesting part of this experiment was the transplanting of fish from one ground to another, by which it was found that on some grounds they would grow three or four times as rapidly as upon other grounds. Experiments upon the same lines have been carried out by the English staff with similar results, but the official English report is not yet published. The marking experiments have also shown that in Danish waters there are decided migrations of plaice at different times of the year, the tendency being for the fish to work into shallower water during the spring and into deeper water during the autumn.

Dr. Martin Knudsen contributes a paper upon the hydrography of the North Atlantic Ocean, while Mr. J. N. Nielsen writes upon the hydrography of the waters of the Færöe Islands and Iceland during 1903. In both these papers we should have liked to see either an introduction stating the objects of the investigation or a summary of results, as, to those who are not hydrographers, the results obtained are not very clearly set forth. It is perhaps too early to attempt to connect the observed physical phenomena with the movements of the fish, but no doubt, as more material comes to hand, the biological results of the international investigations will be shown to be closely dependent upon the physical conditions observed by the hydrographical staff.

A paper by Mr. Neils Bjerrum, on the determination of oxygen in sea-water, is bound in with Mr. Nielsen's paper already referred to. Mr. Bjerrum has adopted a method of "preserving" the water samples taken in mid-ocean until they can be accurately analysed on land, and it appears that his method of adding to the water samples a solution of manganous chloride and caustic soda containing iodide of potassium has been very satisfactory.

FRANK BALFOUR BROWNE.

[1] Meddelelser fra Kommissionen for Havundersøgelser. (Copenhagen, 1904-5.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A statute was brought before Congregation on June 6 to provide a delegacy to superintend the instruction of candidates for the Indian Forest Service, and to grant diplomas in forestry. The proposal to establish a diploma in forestry in the university has arisen from the recent decision of the Secretary of State for India to send the Indian forestry students, hitherto trained at the Coopers Hill Engineering College, to receive their special training in forestry at Oxford. Those students under the regulations just issued by the India Office will be selected by a competitive examination held by the Civil Service examiners every summer. They must be natural born British subjects of not less than eighteen or more than twenty years of age on the January 1 before their selection. They will be required, before becoming candidates, to have passed Responsions or an equivalent examination. The subjects of the competitive examination will be:—(1) mechanics and physics; (2) chemistry; (3) zoology; (4) botany.

After selection the students will be probationers for about three years. For the first two years they will be required to study at Oxford, and their course will include theoretical and practical forestry, and subjects auxiliary to forestry, viz. organic chemistry and the chemistry of soils, geology, forest botany, forest entomology, mathematics, German, and book-keeping. During the third year of probation they will receive practical instruction, visiting Continental forests under suitable supervision. The first competitive examination will be held on August 29 for the selection of not less than nine candidates. Applications for admission must be made to the India Office by July 1.

The Junior Scientific Club gave a conversazione in the museum on Tuesday, May 30, at which more than a thousand visitors were present. Lectures and demonstrations were given by Prof. Poulton, Dr. Tutton, Dr. Brereton Baker, and Mr. E. P. Poulton, and there were a large number of scientific exhibits.

The Robert Boyle lecture for 1905 was given by Sir Victor Horsley on Monday, June 5, in New College Hall. The subject of the lecture was "The Cerebellum."

CAMBRIDGE.—A little pamphlet has just been published on the authority of the Vice-Chancellor containing the names of all those who voted on the report of the examinations and the way they voted. An analysis of the poll shows that amongst the resident members of the university 288 voted in favour of allowing a substitute for Greek in the previous examination and 240 against. Thus the residents had, out of a total of 528 votes, the substantial majority of 48; they were, however, swamped by the non-resident vote. Only four colleges, King's, Christ's, Trinity, and Downing, showed a majority amongst both residents and non-residents in favour of the proposed change.

Prof. Lewis gives notice that a course of lectures and demonstrations in crystallography will be given in the mineralogical lecture-room during the long vacation, beginning at 9 a.m. on Friday, July 7.

The observatory syndicate has reported upon the management of the sum of 5000*l*. bequeathed by the late Mr. Frank McClean for "improving the instrumental equipment of the Newall Observatory." It recommends that the sum be invested, and that the disposal of both the interest and, if advisable, the capital, be in the hands of the syndicate, and that the accounts be annually audited and published with the university accounts.

The special board of medicine has drafted ordinances which, if they pass the Senate, will allow a candidate for the M.B. or M.D., if resident abroad, to take his degree *in absentia*.

THE annual conversazione of University College, London, will be held on the evening of Wednesday, June 28. There will be scientific and other exhibits illustrating the work of the various departments of the college.

MR. E. BROWN, lecturer on applied mechanics at the University of Liverpool, has been appointed assistant professor in civil engineering and applied mechanics in the McGill University at Montreal.

DR. J. E. DUERDEN, of the University of Michigan, formerly curator of the museum, Jamaica, has been appointed professor of zoology at the Rhodes University College, Grahamstown, Cape Colony.

A COURSE of eight lectures in advanced zoology on "The Prosobranchiate Mollusca" is being given in connection with the University of London in the lecture room of the Chelsea Physic Garden by Mr. J. E. S. Moore on Mondays and Thursdays during June. There is no fee for the course; cards of admission and a detailed syllabus may be had on application to the academic registrar, University of London, South Kensington, S.W.

THE King has approved the charter for the constitution of the University of Sheffield. On June 3 the Pro-Chancellor formally handed over the charter to the Vice-Chancellor, Dr. Hicks, F.R.S., and congratulatory speeches were made. The King and Queen have consented to open the new university buildings in July. An endowment fund of about 140,000*l.* has been raised in Sheffield, and the City Council and the councils of neighbouring boroughs and counties have guaranteed annual rate aid equivalent to an even larger capital sum. The first Chancellor of the university is the Duke of Norfolk.

WE learn from *Science* that Prof. Asaph Hall, jun., has resigned the professorship of astronomy and directorship of the observatory at the University of Michigan. Prof. W. T. Hussey, of the Lick Observatory, has been elected his successor. Prof. S. J. Barnett, of Stanford University, has accepted the chair of physics at Tulane University, vacant by the resignation of Dr. Brown Ayres to accept the presidency of the University of Tennessee. At Williams College, Mr. W. E. McElfresh has been promoted to the Thomas T. Reed professorship of physics, and Mr. H. L. Clelland to a professorship in geology. M. Gabriel Bertrand has been appointed to succeed the late M. Duclaux as lecturer on biological chemistry at the Paris Faculty of Science.

IT is announced, *Science* states, that 360,000*l.* has been contributed toward the endowment of 500,000*l.* which is being collected to increase the present amount available for the salaries of the teaching staff of the college of Harvard University. The circular which appeals for additional subscriptions says:—"The position of Harvard to-day among American universities is due not so much to its age, traditions, or able administration as to its noble line of teachers. That the teachers in the college should be the best in the land; that the older professors should be free from the cares of a straitened income; that the younger teachers should be able to give themselves without distraction to their work, and that the best men should not be drawn away to other colleges, but should see before them reasonable promotion in work and salary, is essential to the leadership of Harvard and the culture of her sons." It is pointed out that the total of salaries in Harvard College is about 87,600*l.*, and the average per capita allowance for the staff of 279 teachers is only 314*l.*

AN article entitled "Some Candid Impressions of England" is contributed to the current number of the *National Review* by a "German Resident." The first fact which strikes the contributor is the indifference of Englishmen to their individual duties as citizens of a great Empire, and it seems to him, looking at English schools, that the mainspring of German success is here. He says:—"Our youths, like your youths, are human, and would be lazy if there were no penalty for idleness. But the fact that those who are negligent and lazy at school have to put in an extra year of service, acts as a stimulus and compels the German boy to work, where the English boy spends his time in play." In another place:—"I look at England and see the want of such an influence even in your public schools, which are good in a way, so far as they form character, but bad in that they neglect intellect." As for our primary education, its product seems to the critic surprisingly bad. He says the knowledge imparted in our elementary schools does not seem to be such as is required for the making of good citizens. The majority of our workers, he remarks, read little but the sporting Press, and care for little but betting and sport. It is pointed out that the Germans have destroyed in this generation the superstition that Germany makes only poor and cheap articles. "Our Mercedes motors and scientific and optical instruments are the best and most expensive in the world, and no English article of their class can for a moment compete with them."

THE annual report of the council of the City and Guilds of London Institute was adopted at the yearly meeting of the institute held on June 1. The council directs attention to the diminished income of the institute, owing to the fact that the Mercers' Company, the Fishmongers' Company, and the Corporation have made reductions in their contributions. No reason, it is said, has been assigned for these reductions. At the invitation of the Lord Chancellor, a meeting of the representatives of the principal companies has been held to discuss the situation, and a resolution has been passed expressing a hope that the livery companies will increase, rather than diminish, their subscriptions. The total income for the past year, including donations for special purposes, amounted to 43,432*l.*, of which the Corporation and the livery companies contributed 23,308*l.*, the remainder coming from fees and other receipts. In the previous year the income was 46,829*l.*, of which the Corporation and livery companies contributed 29,385*l.* Sir John Wolfe Barry, in his speech moving the adoption of the report, alluded to an interview with the chairman of the Departmental Committee on the Royal College of Science, South Kensington. He gathered that the general idea of the scheme which will be submitted to the council of the institute is a federation or coordination of all the teaching institutions which are gathered round about South Kensington, and when this takes place the institutions will be in intimate connection with the university. It is held that a system of this kind will be a very great benefit, not only to the general teaching given, but also to post-graduate teaching, which will be largely developed, it is hoped, in the future.

THE report of the Commissioner of Education for the year 1903 has now been published by the United States Bureau of Education. It contains in its 1327 pages an abundance of information concerning all grades of American education, and parts of the educational systems of other countries. It is only possible here to refer to a few of its contents. Dr. Charles F. Thwing, president of Western Reserve University, contributes a chapter on the development of American universities, their organisation, conduct, and relations to the life of the nation. The chapter shows that the growth of university endowment funds has kept pace in the United States with that of the wealth of the country at large. For example, the productive funds of Yale College have increased from about 6000*l.* in 1830 to more than 1,000,000*l.* at the present time. The growth of libraries also has been significant in particular instances, yet Dr. Thwing says the "libraries of most colleges are inadequately furnished and inefficiently administered." The functions of universities in American communities are considered under various aspects. First, as conserving forces in the presence of a democracy inclined to make all things new; then as inspiring with high moral ideals an age inclined to pursue mere material aims. As an agency to promote systematic research—the seeking after truth as such—the university fulfils an increasingly useful function. It presents, as the chapter points out, materials for the study of all truth, in the world of nature and in the world of man. Another chapter of the report deals with education in France, and includes some interesting statistics concerning French universities. It appears that the registration in State universities has increased by about 60 per cent. since 1887, the total registration for 1901 being 29,931 students. The University of Paris greatly outnumbers all others in this respect, its total registration being 12,289 students. Lyons, with 2458 students, and Bordeaux, with 2119, stand next to Paris. As the distribution by faculties, law leads with 10,152 students, medicine follows with 8627, science comes third with 3910 students, and is closely followed by the faculties of letters with 3723 students.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 30.—"The Theory of Photographic Processes, Part ii. On the Chemical Dynamics of Development, including the Microscopy of the Image." By S. E. **Sheppard** and C. E. K. **Mees**. Communicated by Sir William Ramsay, K.C.B., F.R.S.

This paper forms a continuation of a preceding one on the kinetics of development (*Proc.*, lxxiv. pp. 447–473). By microscopical methods, the growth in the thickness of the reduced layer of silver particles, in their size and their number, under varying conditions of exposure and development, has been studied. For the structure of the developed negative the following facts were ascertained:—

(*a*) With constant development for a short time the depth of the image is independent of the exposure.

(*b*) With increased time the depth increases very rapidly at first, reaching a maximum for each exposure, after which it is constant, while the density of reduced silver still increases.

(*c*) With long development the depth increases somewhat with the exposure, a limit naturally being fixed by that of the film.

Size of the Grain.—This increases with the time of development, the *rate* being a function of the exposure, but the limiting size independent of this, and fixed by the original haloid grain. Thus in the early stages of development the size of the grain increases with exposure, but on ultimate development is independent of it.

Soluble bromides at moderate concentration give a smaller grain for the same time of development, but depending on the exposure. On ultimate development the size becomes the same.

Number of Grains Reduced.—In the surface-area the number is independent of the exposure, but in the volume unit for moderately long development the number increases with the exposure, and is nearly proportional to the density. It increases rapidly with the time of development, more so than the density, and soon reaches a maximum.

When plates are exposed through the glass side, the thickness of the reduced layer is much the same, but the numbers less. Further, the grains nearer the glass are larger, showing that the more exposed grains start development first. Generally, each grain develops as an isolated system, only uniting to form "aggregates" when the packing is close, as in high exposures. The true reaction-layer is in the gelatin skin surrounding the grain, its thickness being of the order 0·0005 mm., and the reaction is similar to the catalysis of H_2O_2 by colloidal metals, with convection excluded.

Early Stages of Development.—From considerations of the order of reactions the validity of the Watkins factorial method of development is discussed, and the "time of appearance" shown to be a measure of the development-velocity for the initial stage of development. For ferrous oxalate this initial velocity is shown to be proportional to the concentration.

Effect of temperature for ferrous oxalate can be represented by the formula of van 't Hoff, $\log K = -A/T + C$, but the temperature-coefficient for 10°, $K+10^\circ/K$, varies for different developers and emulsions, and cannot serve as a criterion for distinguishing rate of chemical action from diffusion in development.

It is further shown that "tanning" the film with formalin does not alter the development-velocity.

For the "penetration" of the developer, it was found that with plates exposed from the back the image appeared on the glass or film side first according to the exposure. This is explained by consideration of the micro-structure of the exposed film, and the conclusion is again obtained that the "re-activity" or readiness to start development of the individual grain is a steady function of the exposure.

From the absolute "time of appearance" of the image at the back it is concluded that the diffusion-induction is not great, especially since other considerations show that in the early stages of development the chemical reaction has more influence than diffusion.

Chemical Society, May 17.—Prof. R. Meldola, F.R.S., president, in the chair.—The desmotropic form of substances of the ethyl acetoacetate type in the homogeneous state and dissolved in neutral media: J. W. **Brühl** and H. **Schröder**. The authors claim to have established by optical measurements with solutions in various media that both the ethyl acetoacetates and their secondary and tertiary alkyl derivatives, and also the camphorcarboxylic esters and their alkyl derivatives, display a pure uniform ketonic structure, and are free from the enolic forms.—The chlorination of methyl derivatives of pyridine, part i., 2-methylpyridine: W. J. **Sell**. The compound C_6HCl_6N was obtained by chlorinating 2-methylpyridine in hydrochloric acid solution.—The absorption spectra of uric acid, murexide, and the ureides, in relation to colour and their chemical structure: W. N. **Hartley**. The ureides, diureides, and some oxypurin derivatives are divided by the characters of their absorption spectra into two groups, the oximino-ketones with no ethylenic linking associated with the carbonyl groups, and the substances which have one or more such linkings.—Observations on chemical structure and physical properties associated with the theory of colour: W. N. **Hartley**. The main feature in a coloured substance is the occurrence in two parts of the molecule of ethylenic and benzenoid groupings and of ketonic groupings. The explanation of colour, based on the change from a double linking (ketonic) to a single linking (enolic), should, if sound, be capable of explaining the occurrence of six bands in the spectrum of benzene, four in that of naphthalene, and four in that of anthracene. It is shown how this is possible from Kekulé's formula for benzene, and how this formula may be reconciled with the "centric" formula.—Further studies on dihydroxymaleic acid: H. J. H. **Fenton**. This paper describes the results of a study of the condensation of the acid with ammonia, and the behaviour of the acid and its esters towards various hydrazines.—The influence of light on diazo-reactions, preliminary notice: K. J. P. **Orton** and J. E. **Coates**, and (in part) F. **Burdett**.—Behaviour of solutions of propyl alcohol towards semi-permeable membranes: A. **Findlay** and F. C. **Short**. Some years ago Pickering stated that when a porous pot containing a 57 per cent. aqueous solution of propyl alcohol was immersed in either pure water or pure propyl alcohol, the water or the alcohol passed inwards to the solution. The authors have been unable to confirm Pickering's experiments, and suggest that the behaviour observed by him might be temporary and due to differences in the velocity of the diffusion of the pure liquids and the solution.—The thermal decomposition of formaldehyde and acetaldehyde: W. A. **Bone** and H. L. **Smith**. Formaldehyde decomposes at all temperatures between 400° and 1125° in accordance with the equation $CH_2O = CO + H_2$, and acetaldehyde at 400° in accordance with the equation $CH_3.CHO = CH_4 + CO$.—The synthesis of formaldehyde: D. L. **Chapman** and A. **Holt**, jun. The authors have succeeded in synthesising formaldehyde by maintaining a platinum wire at a high temperature in the following mixtures:—(*a*) carbon monoxide and hydrogen; (*b*) carbon monoxide, hydrogen, and steam; (*c*) carbon monoxide and steam; (*d*) carbon dioxide and hydrogen.—Oxymercuric perchlorates and the action of alcohol on mercury perchlorates: M. **Chikashigé**. Three new oxymercuric perchlorates are described.—The constitution of pilocarpine, part v., conversion of *iso*pilocarpine into pilocarpine: H. A. D. **Jowett**.

Royal Meteorological Society, May 17.—Capt D. Wilson-Barker, vice-president, in the chair.—Measurement of evaporation: R. **Strachan**. The author pointed out that the rainfall, evaporation, and percolation are related to each other, and that rainfall is commonly considered to form the sum of evaporation and percolation. If two of these quantities are found by experiment or observation, the other is assumed to be known. This, however, does not always hold good. A month may be very dry, and still evaporation will go on at the expense of previous percolation—and otherwise. A month may be excessively wet, then there may be another item to take into account, viz. overflow. As, unfortunately, it is not possible to make evaporation and percolation the subject of experi-

ment, except at a very few observatories, the author thinks it is desirable to be able to estimate, even empirically, the probable amounts of each. By using the meteorological data published for the Royal Observatory, Greenwich, he has calculated the probable evaporation for the year 1898, which agrees very closely with the observed evaporation at Camden Square and also at Croydon.—On a logarithmic slide-rule for reducing readings of the barometer to sea-level: J. **Ball.** This has been devised for the purpose of saving the time and labour usually occupied in working out the corrections from the international meteorological tables.

Royal Microscopical Society, May 17.—Dr. Dukinfield H. Scott, F.R.S., president, in the chair.—The movements of diatoms and other microscopic plants: D. D. **Jackson.** The author describes the observations and experiments made by him, some with artificial diatoms, which have led him to the conclusion that the movements referred to are caused by the escape of oxygen gas evolved in these organisms.

Faraday Society, May 18.—Dr F. Mollwo Perkin, treasurer, in the chair.—An application to electrolytes of the hydrate theory of solutions: Dr. T. Martin **Lowry.** The object of the paper is to consider the possibility of extending the hydrate theory to electrolytes in such a way as to take account of the observations which form the experimental basis of the theory of electrolytic dissociation. The hydrate theory postulates that an aqueous salt solution consists of a mixture of hydrates in equilibrium with the solvent and with one another. But it must be supposed that even in solution there is a limit to the possibility of hydrate formation, so that ultimately a stage will be reached at which the molecule as such will be unable to combine with any further quantity of water. The ionisation of an aqueous electrolyte consists essentially in a further process of hydration whereby the fully hydrated molecule combines with an additional quantity of water to form two or more hydrated ions. The hydration of the ions is thus conceived to be the primary cause of the ionisation of aqueous electrolytes. It is believed that this extension of the hydrate theory to the phenomena of electrolysis may help to remove the fundamental difficulty of Arrhenius's theory, namely, the absence of a motive for electrolytic dissociation.

Physical Society, May 26.—Meeting at the National Physical Laboratory by invitation of the director, Dr. Glazebrook.—The following special demonstrations were made:—The specific heat of iron at high temperatures: Dr. J. A. **Harker.** A knowledge of the specific heat of iron is important in the determination of high temperatures by calorimetric methods. Dr. Harker has determined the total heat of iron up to temperatures of 900° C. by heating the specimen in an electric furnace, the temperature of which was determined by a resistance thermometer, and dropping the iron into a water calorimeter. Dr. Harker also exhibited some new types of electric furnace for the attainment in absence of noxious gases of temperatures between 800° C. and 2200° C. The conductor conveying the electric current is a tube of solid electrolytes similar in composition to the filament of a Nernst lamp. An essential feature is that, for many purposes, the usefulness and life of a furnace constructed in this way may be much increased by adopting a "cascade" system of heating.—Apparatus for the measurement of small inductances: A. **Campbell.** The method of measurement is that adopted by Max Wien, and described by him in a paper on "Magnetisation by Alternating Currents" (*Wied. Ann.*, xiii., August, 1898). It is a modification of Maxwell's method of comparing two self-inductances, the source of voltage being alternating, and the indicating instrument a tuned optical telephone or vibration galvanometer.—Two new optical benches constructed for the laboratory by Messrs. R. and J. Beck: J. **Selby.** One of these is specially designed for the rapid testing of spherical and cylindrical lenses, such as are found in oculists' trial cases. The second bench is designed for the determination of the loss of light by absorption and reflection in telescopes and binoculars.

CAMBRIDGE.

Philosophical Society, May 1.—Prof. Liveing, vice-president, in the chair.—On the striation of the positive column in electric discharges: Prof. **Thomson.** The author considered the ionisation in a discharge tube by the collision of charged ions as well as of corpuscles against the molecules of a gas, and showed that if the pressure in the tube and the electric current through it had values situated between certain limits, there would be periodic alternations in the positive column analogous to striations.—On the calculation of the coefficient of re-combination of the ions and the size of the ions: Prof. **Thomson.** The re-combination of ions is due to oppositely charged ions attracting each other and forming a single system. When the ions are at a distance r apart the work required to separate them to an infinite distance is e^2/r, hence two ions starting from a distance r apart will not describe closed orbits about each other, *i.e.* will not combine if their kinetic energy is greater than e^2/r. Since the ions behave like the molecules of a gas, their kinetic energy will depend only upon the temperature, and can be calculated when that is known. If T is this kinetic energy, then for combination to take place e^2/r must be greater than T, or r less than e^2/T. Hence to find the number of re-combinations in any time, all we have to do is to find the number of pairs of ions which within that time get within a distance e^2/T of each other. This number, and hence the coefficient of re-combination, is easily calculated. If we assume that the ions in hydrogen are charged molecules of hydrogen, the coefficient of re-combination at 0° C. would be $1{\cdot}5\times10^{-6}$; the value found by experiment is about 10^{-6}, hence we conclude that the hydrogen ion is more complex than the hydrogen molecule. The kinetic energy due to temperature is shown to prevent the ions getting very much larger than the molecules; thus if the radius of the molecule were 10^{-8} cm., the radius of the ion could not exceed 3×10^{-8}.—Some physical properties of sodium vapour: P. V. **Bevan.** The experiments described in this paper were made to investigate the phenomena of the cloud of sodium vapour formed by heating a piece of metallic sodium *in vacuo* or in an atmosphere of hydrogen. In certain circumstances the sodium vapour forms a very sharply defined cloud with apparently a definite surface across which diffusion does not take place. The formation of this cloud, which was discovered by Prof. R. W. Wood, was found to be conditioned by the presence of water vapour in the atmosphere in which the sodium was heated. *In vacuo* the sodium vapour behaves like any other vapour, and in perfectly dry hydrogen there is no definite surface to the vapour observable when the sodium is heated. It was also shown that *in vacuo* the sodium begins to form vapour at the temperature of boiling water. The view is put forward that when the sodium cloud is seen on heating sodium in a vacuum tube the effect is due to the formation of an atmosphere of hydrogen occluded by the sodium and formed by the action of the sodium on sodium hydroxide.—A null method of measuring small ionisations: N. R. **Campbell.** Measurements have been made of spontaneous ionisations by adjusting the pressure of the air in a closed vessel containing a constant amount of uranium until the current through that vessel was equal and opposite to that through the spontaneously ionised gas. By this device certain difficulties connected with the measurement of capacity and the preservation of insulation are avoided.—The reflexion of sound at a paraboloid: Rev. H. J. **Sharpe.**

DUBLIN.

Royal Dublin Society, April 18.—Prof. J. A. McClelland in the chair.—Notes on the constitution of nitric acid and its hydrates: W. Noel **Hartley.** The author referred to a paper by him published in 1903 in the *Chem. Soc. Trans.* on the absorption spectra of nitric acid in various states of concentration. He had assigned the formula H_3NO_4 to normal nitric acid, and suggested that the several hydrates described were hydrates of this acid; but H. Erdmann, also in 1903, having isolated and described five nitric acids, the author was led to revise the formulæ of the hydrates in accordance with the constitution of these

compounds. The normal acid being pentabasic, $N(OH)_5$, there are several hydrates of this extending to

$$N(OH)_5.14H_2O.$$

Ordinary nitric acid of 1·42 sp. gr. consists entirely of the octobasic acid $(HO)_4N.O.N(OH)_4$, and the crystallisation of this was shown to the meeting by cooling the acid in liquid air.—The effect of very low temperature on moist seeds: John **Adams.** Seven species of moist seeds were submitted to the temperature of liquid air, with the result that they were all killed, while dry seeds were not adversely affected. The physiological processes involved were next considered, as well as the various theories put forward to account for death by freezing. An attempt was made to bring the results obtained into line with Macfadyen's experiments on bacteria, and the more recent investigations of Edwin J. Smith and Deane B. Swingle.—Injurious insects and other animals observed in Ireland during the year 1904: Prof. G. H. **Carpenter.** In this paper special attention is paid to Cecidomyiidæ, the pear-midge (*Diplosis pyrivora,* Riley) being recorded, and an account of *Rhabdophaga heterotia,* Loew., very destructive to osier beds in the county of Kilkenny, being given. Further instances are mentioned of Collembola injurious to plant roots and a new species of oribatid mite (*Lohmannia insignis,* Berlese) destructive to bean seedlings is described. The life-history of the well known mangold fly (*Pegomyia betae,* Curtis) is worked out in some detail.—Prof. **McClelland** made an addition to the communication he laid before the society at its February meeting.

EDINBURGH.

Royal Society, May 1.—Prof. Geikie in the chair.—The internal structure of *Sigillaria elegans* of Brongniart's "Histoire des Végétaux fossiles": R. **Kidston.** The primary xylon formed a continuous ring as in *S. elongata,* Bgt., described by Prof. Bertrand, but the protoxylon groups formed rounded projections, not pointed, as in *S. elongata.* The paper concluded with some general remarks on the development of the primary xylon of the Carboniferous lycopods, and the opinion was expressed that the solid stele was the most primitive type, followed by the continuous ring with a medulla, the series ending in that type of structure found in *S. spinulosa,* where the primary xylon assumes the form of a circle of isolated bundles.—The rainfall of the drainage area of the Talla reservoir: B. Hall **Blyth** and W. A. **Tait.** The observations had been carried out in connection with the new Edinburgh Water Works in order to obtain data for fixing an equitable compensation to the Tweed Salmon Fisheries Commissioners and other proprietors in the district. Seven gauges had been established at various levels, and observations had been taken continuously for seven years from 1896. The lowest gauge, at a height of 966 feet, gave an annual average of 61·43 inches, and the highest, at a height of 2627 feet, gave 65·53 inches, or only 0·41 per cent. per 100 feet rise. The greatest average was given by the gauge at the height of 1537 feet, the value being 73·92 inches. These facts showed that the rainfall was greatly affected by the exposure to prevailing winds and the character of these winds, quite apart from the effect of height. The extent of the drainage area was 6180 acres, and the average annual rainfall, as estimated from the observations, was nearly 14,600,000 gallons per day, of which one-third had to be given off as compensation.—The rainfall records in the Talla drainage area from 1896 to 1902: P. D. **Donald.** This contained further discussions of the records. The observations of rainfall were being continued by the Water Trust, and it was hoped that the information so gained would be of special value to all interested in water supply.—Variant forms of vanishing aggregates of minors of axisymmetric determinants: Prof. **Metzler.**

PARIS.

Academy of Sciences, May 29.—M. Troost in the chair.—The exact transmission of time by the telephone: E. **Guyou** (see p. 134).—On cyanocampho-acetic, cyanocampho-α-propionic, cyanocampho-α-butyric acids and their principal derivatives: A. **Haller** and A. **Couréménos.** The sodium derivative of cyanocamphor reacts with the methyl and ethyl esters of the α-monochlor- and monobromo fatty acids similarly to the alkyl iodides and bromides previously studied, the camphor derivative behaving as if it possessed the enolic form. These new compounds can be saponified by alcoholic potash, furnishing the corresponding acids, several esters, salts, and amides being described in detail.—The oscillations of locomotives under the action of various disturbing forces: Georges **Marié.** A study of the conditions under which the oscillations may accumulate to a dangerous amplitude, and of the means of avoiding these conditions in practice.—On the continued algebraical fractions of Laguerre: R. de Montessus **de Ballore.**—On partial differential equations of the elliptic type: S. **Bernstein.**—On the interpolation of continuous functions by polynomials: Martin **Krause.**—The electrolytic production of very fine wires: Henri **Abraham.** Starting with a fine drawn wire of a given material, the metal is removed electrolytically in a suitable bath, the resistance of the wire being measured during the experiment, the increase of the resistance giving an exact measure of the reduction of the diameter. For the production of uniform wires it is necessary that the electrolysis be conducted very slowly, and the method proved very successful for the purpose in view.—On tangential irradiation: A. **Guébhard.** A discussion of the mechanical and electrical theories as to the cause of photographic irradiation.—The examination of phosphorus sulphide for the presence of free white phosphorus: Léo **Vignon.** The Mitscherlich reaction (distillation with water) is useless for detecting free phosphorus in commercial phosphorus sulphide; the removal of the free phosphorus by heating in a current of hydrogen proved more serviceable.—On a reaction with discontinuous velocities of the green sulphate of chromium: Albert **Colson.**—On some physical properties of propane: Paul **Lebeau.** Pure propane was obtained from three sources, normal propyl iodide, isopropyl iodide, and isopropyl chloride, the final purification being effected in all three cases by fractional distillation of the liquefied gas. It remained liquid at the temperature of liquid air (−195°), boiled at −44°·5 C., and had a critical temperature of 97°·5 C., the critical pressure being 45 atmospheres. Propane is soluble in several reagents, its solubility being much greater than either methane or ethane. It is interesting to note that although propane does not solidify at −195° C., methane, its lower homologue, is crystalline at −184° C.—On methyl-acetyl-carbinol: André **Kling.** This acetol can be obtained by the oxidation of 2:3-butanediol by the action of the sorbose bacterium and by *Mycoderma aceti.* The resulting keto-alcohol is dextrorotatory, the oxidation proceeding at the expense of the lævo-form. The semicarbazone is well crystallised and readily isolated, and forms the best means of identifying this substance.—On the oxide of methoethenylbenzene: M. **Tiffenau.**—Syntheses in the anthracene series. The condensation of derivatives of benzodihydrofurfurane into γ-substituted anthracene derivatives: A. **Guyot** and J. **Catel.**—On methylnatalœmodine and natalœmodine: E. **Léger.** The name natalœmodine is given to a trioxymethyl-anthraquinone obtained by the action of sodium peroxide upon the aloin from Cape aloes. Details are given of its properties and the preparation of some of its derivatives.—On the acidity of some ethyl alcohols of commerce and on the variations in acidity at the ordinary temperature: René **Duchemin** and Jacques **Dourlen.** Alcohol slowly oxidises in the presence of air at the ordinary temperature, acetic acid being formed. The amount formed depends on the nature of the containing vessel.—The conductivity of colloidal solutions: J. **Duclaux.** A solution of a colloid can be filtered through a collodion film, crystalline substances passing readily through such a filter, the colloid remaining behind. It was found that the conductivity of the concentrated solution of the colloid was appreciably greater than that of the filtrate. From the results of the measurements it was calculated that the electric charge on each particle of colloidal ferric hydrate was about 1/500th of that corresponding to the gram-valence of an ion.—On the presence of noumeite in the detritic state in the neo-Caledonian Eocene: M. **Deprat.**—The wild coffee trees of French Guinea: A.

Chevalier.—On *Oïdium lactis* and the ripening of cream and cheese: J. **Arthaud-Berthet.**—On *Stearophora radicicola*, a fungus of the roots of the vine: L. **Mangin** and P. **Viala.**—The pathogenic action of *Stearophora radicicola* on animals: MM. **Charrin** and **Le Play.**—The phenomena of sexuality in the development of the Actinomyxides: M. **Caullery** and F. **Mesnil.**—The histological phenomena of asexual reproduction in Salmacina and Filograna: A. **Malaquin.**—Some variations in the coefficient of demineralisation in animals in a state of acid dyscrasia: A. **Desgrez** and Mlle. Bl. **Guende.**—The experimental reproduction of human cancer: M. **Mayet.**—On distemper in dogs: H. **Carré.**—On the geology of the Piedmont zone: Maurice **Lugeon** and Émile **Argand.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 8.

ROYAL SOCIETY, at 4.30.—Researches on Explosives. Part III.: Sir Andrew Noble, Bart., K.C.B., F.R.S. (1) On the Thermoelectric Junction as a Means of Determining the Lowest Temperatures; (2) Studies with the Liquid Hydrogen and Air Calorimeters: Sir James Dewar, F.R.S.—Colours in Metal Glasses, and in Metallic Films and Metallic Solution: J. C. Maxwell Garnett.—On the Application of Statistical Mechanics to the General Dynamics of Matter and Ether. The General Method of Statistical Mechanics: J. H. Jeans.—On the Magnetic Qualities of some Alloys not containing Iron: Prof. J. A. Fleming, F.R.S., and R. A. Hadfield.—On the Phosphorescent Spectra of Sδ and Europium: Sir William Crookes, F.R.S.—On the Perturbations of the Bielid Meteors: Dr. A. M. W. Downing, F.R.S.—The Asymptotic Expansion of Integral Functions defined by Taylor's Series: Rev. E. W. Barnes.—Preliminary Note on Observations made with a Horizontal Pendulum in the Antarctic Regions: Prof. J. Milne, F.R.S.—Note Supplementary to a Paper "On the Radio-active Minerals": Hon. R. J. Strutt, F.R.S.—The Morphology of the Ungulate Placenta, particularly the Development of that Organ in the Sheep, and Notes upon the Placenta of the Elephant and Hyrax: R. Assheton.—A Preliminary Communication on the Life History of *Trypanosoma balbianii*: W. S. Perrin.—On the Effect of Carbon Dioxide on Geotropic Curvature of the Roots of *Pisum Sativum*: E. Drabble and Miss H. Lake.—The Pharmacology of Indaconitine and Bikhaconitine: Prof. J. T. Cash, F.R.S., and Prof. W. R. Dunstan, F.R.S.—Preliminary Note on the Occurrence of Microsporangia in Organic Connection with the Foliage of Lyginodendron: R. Kidston, F.R.S.—Chitin in the Carapace of *Pterygotus Osiliensis* from the Silurian of Oesel: Dr. Otto Rosenheim.—(1) The Synthesis of a Substance allied to Adrenalin; (2) On the Physiological Activity of Substances indirectly allied to Adrenalin: Dr. H. D. Dakin.

ROYAL INSTITUTION, at 5.—Electromagnetic Waves: Prof. J. A. Fleming, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—On a Class of Many-valued Functions Defined by a Definite Integral: G. H. Hardy.—On the Condition of Reducibility of any Group of Linear Substitutions: Prof. W. Burnside. On Criteria for the Finiteness of the Order of a Group of Linear Substitutions: Prof. W. Burnside.

FRIDAY, JUNE 9.

ROYAL INSTITUTION, at 9.—Submarine Navigation: Sir William White, K.C.B., F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Meteors from Biela's Comet: W. F. Denning.—On the Formula for connecting Diameters of Photographic Images with Stellar Magnitude: H. H. Turner.—(1) The Moon's Observed Latitude, 1847–1901; (2) On the Discordant Values of the Principal Elliptic Coefficients in the Moon's Longitude: P. H. Cowell.—Determinations of Stellar Parallax from Photographs taken at the Cambridge Observatory. Introductory Paper: A. R. Hinks and H. N. Russell.—The Most Probable Position of a Point determined from the Intersections of Three Straight Lines: S. A. Saunder.—On the Relative Efficiency of Different Methods of Determining Longitudes on Jupiter: A. Stanley Williams.

SATURDAY, JUNE 10.

ROYAL INSTITUTION, at 3.—Exploration in the Philippines: A. H. Savage Landor.

WEDNESDAY, JUNE 14.

MINERALOGICAL SOCIETY, at 8.—The Chemical Composition of Lengenbachite: Dr. A. Hutchinson.—The Identity of the Ancient Amiantos of Cyprus with Chrysotile: Dr. J. W. Evans.—The Chemical Composition of Hutchinsonite: G. T. Prior.

CHEMICAL SOCIETY, at 5.30.—Influence of Various Sodium Salts on the Solubility of Sparingly Soluble Acids: J. C. Philip.—The Dielectric Constants of Phenols and their Ethers Dissolved in Benzene and *m*-Xylene: J. C. Philip and Miss D. Haynes.—Synthesis by Means of the Silent Electric Discharge: J. N. Collie.—The Ultra-violet Absorption Spectra of Benzene and Certain of the Mono-substituted Derivatives: E. C. C. Baly and J. N. Collie.—Association in Mixed Solvents: G. Barger.—The Ultra-violet Absorption Spectra of Derivatives of Benzene. Part II. The Phenols: E. C. C. Baly and Miss E. K. Ewbank.—The Action of Water on Diazo-salts. A Preliminary Note: J. C. Cain and J. M. Norman.—Synthesis of Substances Allied to Epinephrine: G. Barger and H. A. D. Jowett.—A Precise Method of Determining the Organic Nitrogen in Potable Waters: J. Campbell Brown.—Synthesis of 1:1-Dimethyl-Δ^3-tetrahydrobenzene: A. W. Crossley and Miss N. Renouf.—Bromine in Solutions of Potassium Bromide: F. P. Worley.

THURSDAY, JUNE 15.

LINNEAN SOCIETY, at 8.—Biscayan Plankton. Part VI. Colloid Radiolaria: Dr. R. N. Wolfenden.—Biscayan Plankton. Part VII. Mollusca: Dr. P. Pelsener.—(1) Longitudinal Nerves and Transverse Veins in Bamboos; (2) Some Indian Undershrubs: Sir D. Brandis, K.C.I.E., F.R.S.—Notes on a Skeleton of the Musk-duck, *Bizuria lobata*: W. P. Pycraft.—*Exhibitions*: *Arum maculatum*, in Relation to Insects (with lantern slides): Rev. J. Gerard, S.J.

FRIDAY, JUNE 16.

PHYSICAL SOCIETY, at 8.—On the Ratio between the Mean Spherical and Mean Horizontal Candle-power of Incandescent Lamps: Prof. J. A. Fleming, F.R.S.—The Electrical Conductivity of Flames: Dr. H. A. Wilson.—Contact with Dielectrics: R. Appleyard.—The Pendulum Accelerometer, an Instrument for the Direct Measurement and Recording of Acceleration: F. Lanchester.—A New Form of Pyknometer: N. V. Stanford.—Exhibition of a Refractometer: R. Appleyard.

MALACOLOGICAL SOCIETY, at 8.—Lecture on the Prosobranchiate Mollusca: J. E. S. Moore.—On the Extension of the Genus Macrochlamys to the Island of Mauritius: Lieut.-Col. H. H. Godwin-Austen.—Mollusca of the Porcupine Expeditions, Supplemental Notes, Part II.: E. R. Sykes.—On a Small Collection of Mollusca from Tierra del Fuego: E. A. Smith.—On two Miocene Gastropods from Roumania: R. Bullen Newton.—Revision of the New Zealand Patellidæ, with Descriptions of a New Species and Subspecies: Henry Suter.—The Conchological Writings of Captain Thomas Brown: C. Davies Sherborn.

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THURSDAY, JUNE 15, 1905.

SOME RECENT BOOKS ON CELTIC.

Keltic Researches. By E. W. B. Nicholson. Pp. xviii+212. (Oxford: Clarendon Press; London: Henry Frowde, 1904.) Price 21s. net.

The Mythology of the British Islands. By Charles Squire. Pp. x+446. (London: Blackie and Son, Ltd., 1905.)

The Literature of the Celts, its History and Romance. By Magnus Maclean. Pp. xv+400. (London: Blackie and Son, Ltd., 1902.)

THOSE who have the study of Celtic at heart cannot but be rejoiced at the strides which it has made in recent years. At no period have the inhabitants of the Celtic countries—those of Wales and Ireland more especially—shown a keener interest in their languages and institutions than at the present day; the number of scholars engaged in Celtic research has never been so great; and this Celtic revival, so-called, is like to prove no passing outburst, fanned by eccentrics and sentimentalists; rather we should see in it the coming of the race into its own again, the reaping after many days of a rich harvest of literature and legend.

In the case of the Welsh, the movement has been partly the cause, partly the effect of the movement towards improved education, and is no longer of yesterday. It can be traced back some seventy years, to the founding of the British schools by the late Sir Hugh Owen. Thirty years later the same enlightened patriot added discussions, both learned and practical, on matters affecting the Principality, to the musical and literary contests at the Eisteddfod. About the same time the study of the Welsh language, which owed what life it had to the devoted labours of Chancellor Silvan Evans, received a fresh direction from the papers and speeches of Prof. Rhys, who inveighed against the school of Dr. Owen Pughe, and pointed the way to more scientific methods. The last fifty years have been marked by a steady, if gradual, advance; the interest in Wales and things Welsh, and the sense of nationality, have become ever keener and more real, the language has secured a fresh lease of life, and the study of philology and history has been, and continues to be, vigorous and fruitful; not the least happy augury for the future is the fact that a number of younger men, natives of the Principality, have already made a name in these fields.

Unlike the Welsh, by which it may have been in part suggested, the Irish revival is of comparatively recent date. It is none the less vigorous on that account. Within the last few years, owing largely to the efforts of the Gaelic League, Irish has been studied with eagerness by persons of every shade of opinion, and a determined attempt has been made to develop native industries. A society has been founded for the publication of Irish texts—it has already done considerable work—and a special school, the School of Irish Learning, has been started to give students a scientific training in the language and to open up the rich treasures of Irish literature. The necessary funds are provided in part by voluntary subscription, and the generous donor may hope that he is helping to raise up a race of scholars as devoted as O'Curry and O'Donovan, as distinguished as Stokes and O'Grady. Up to this present, there has been no corresponding movement among the Scotch Highlanders or the other Celtic peoples, but it will not be the fault of their congeners if their national aspirations remain unawakened. The Pan-Celtic Congress, which met for the first time in 1901, has for one of its aims to increase the feeling of union among "the sea-divided Gaels" themselves; it is attended by delegates from all the Celtic districts, as well from Brittany as from those on this side of the Channel.

Apart from the enthusiasm of the Celtic-speaking races for their own language and institutions, there is a growing tendency among the other inhabitants of these islands—themselves far from purely Teutonic—to recognise the importance of the Celtic element and to wish to be enlightened as to its history and literature. It is doubtless to meet this demand that there have appeared of late years a number of books on Celtic subjects, written not so much for the specialist as for the general public. Of the books at the head of this notice two—Mr. Squire's "Mythology" and Mr. Maclean's "Literature"—are of this more or less popular character. All three alike are the work of men whose distinctions are not confined to Celtic, and bear witness to the increasing interest which it is exciting among the British nation as a whole.

Mr. Nicholson's "Keltic Researches," as the subtitle indicates, are a series of studies in the history of the ancient Goidelic languages and peoples. The author's first object is to demonstrate to philologists certain unrecognised or imperfectly recognised linguistic facts; but, inasmuch as he has not made Celtic his one and only study, he does not write in a narrow, specialising spirit; his linguistic facts are important, but he values them chiefly for the light which they throw on history in general, on the Pictish question, on the Menapian settlements, and on the distribution of the Celtic languages in Britain and on the Continent. The main philological result of the book is to show that the loss of original *p*, a loss supposed to be the main characteristic of the Celtic languages, is of comparatively late date in the Goidelic group, that, in fact, *p* was kept at Bordeaux until the fifth century A.D. Those who wish to be satisfied as to the soundness of his linguistic foundation are advised to turn to the appendices, which make up a third of his book, immediately after reading the first eight pages.

We need scarcely point out that much of his matter is controversial, and that some of his conclusions are liable to be disputed. For instance, many will refuse to admit that the Picts spoke a tongue virtually identical with Gaelic; they will maintain with Stokes that they spoke something nearer akin to Welsh, or with Zimmer and Rhys that their language was not Aryan at all. On the other hand, there can be little doubt as to the correctness of his main linguistic results. Exception may be taken to the interpretation of his *pièces justificatives*, the Rom tablets and the Coligny calendar; but he is certainly right in inferring that, besides those of the Gallo-Brythonic branch, there existed in

Gaul a language or languages closely akin to Goidelic or ancient Gaelic of the British Isles. Strange to say, although every Celtist knows that the peoples of the Gallo-Brythonic group had *p* for *qu* from time immemorial—petor in Gaulish petorritum=Latin quatuor—and that those of the Goidelic branch retained *qu* like the Romans, the greater number have chosen to assume that Gaulish was co-extensive with Celtic on the Continent. In spite of the evidence of such names as Aquitania, Sequana, Sequani, it was the fashion to suppose that *qu* was unknown in Gaul and that all the Celts alike dropped the consonant *p* of the Indo-European parent speech, as, for instance, in Aremorica, Armorica, where *are* is approximately equivalent to the Greek παρά. In laying stress on the fact that the retention of the old *qu* and Indo-European *p* are characteristic of the Pictavian and Sequanian languages he has done valuable service to the cause of philology, and recalled Celtic scholars from a path of error. He does not, indeed, claim to be the first to point out that the Celtic languages of the Continent were not of one and the same type. He tells us that as early as 1847 Jacob Grimm showed that the charms in the work of Marcellus of Bordeaux were in a language virtually identical with old Irish, and that Pictet afterwards proved that Indo-European *p* was retained in one of these charms in the prefix *pro*. Half a century later (in February, 1891), in a paper read before the Philological Society, Prof. Rhys brought together certain *qu* names from the Continent to prove the same thesis, and proposed that the language in Gaul akin to Goidelic should be called Celtican. He insisted on the significance of the words of Sulpicius Severus in Dialog. I. 27, "Tu vero, inquit Postumianus, vel Celtice, aut si mavis, Gallice loquere, dummodo jam Martinum loquaris." So, too, Mr. Macbain, in the introduction to his etymological dictionary of the Gaelic Language (Inverness, 1896), inserts among the *q* group by the side of Goidelic "dialects in Spain and Gaul." This was not long before the Coligny calendar and the Rom inscriptions came to light, showing that the Sequani and the Pictones, at any rate, spoke languages belonging to the same group as old Irish.

There can be no question that the book deserves study. If it sometimes betrays inexperience—and the author would be the first to admit this—it shows signs of many-sided learning, and in some cases of rare insight; the whole breathes an impartiality and generous candour which are wanting in many searchers after truth.

"The Mythology of the British Islands," by Charles Squire, is an introduction to Celtic myth, legend, poetry, and romance. It is intended, as we have seen, not for the learned, but for the ordinary reader, and the subject is approached from the literary rather than from the scholastic standpoint. Believing that the classic fount from which the poet so long drew inspiration has lost its potency, that the Greek stories can no longer be handled save by the genius alone, the author has attempted to put the natives of these islands in possession of a new heritage of myth and tradition, a heritage which is as much their own as that of the Teutons and Scandinavians.

Although the Welsh mabinogi and romances, and much of the Gaelic saga, have been made accessible in translations, it is unlikely that the British public as a whole can have formed anything like an adequate idea of Celtic mythology. The works in point contain but few explanations, and he who opens them for the first time, while he may be sensible of their charm, cannot but be bewildered by the novelty of his surroundings. He feels that he has ventured into a new world, peopled by characters whose very names are, for the most part, unfamiliar. If he wishes to understand their setting, to trace the connection between them, he must peruse innumerable lectures and learned essays, a task which is like to prove no light one. Mr. Squire's book is calculated to meet his difficulty. In it he will at last be formally introduced to the personages of Celtic mythology, to the gods and giants of the Gaels, to the champions of the Red Branch of Ulster—heroes of an epic almost worthy to rank with that of Troy—and to Finn and his Fenians. He will also make acquaintance with the chief figures of the Brythonic Pantheon, with the earlier race of gods, and with Arthur and his knights, who will be seen to belong to the same company.

As our author does not claim to have written an original work, it goes without saying that we are not called upon to enter into a discussion of his subject-matter. He has studied the works of the best scholars, and for the most part he adheres to them faithfully. It is possible that in some cases he may show himself over positive, that he may be inclined to treat as certain what his authority has advanced as a conjecture. But since his sole object in writing is to gain a larger audience for the studies of others, slips of this kind cannot be regarded as serious.

In our opinion his book is both useful and attractive. His treatment of his subject is thorough and conscientious, and he has realised his hope of presenting it in a lucid and agreeable form. It will be matter for surprise if he does not inspire his readers with some at least of his own enthusiasm.

Of Mr. Maclean's "Celtic Literature" there is no need to say more than a few words. It is some time since it appeared, and we doubt not that many of the readers of this Journal are already well acquainted with it It is the first attempt to give in brief compass an account of Celtic literature from the earliest times to the present day. Like Mr. Squire's "Mythology," it is intended to serve as a popular introduction; at the same time, it aims at satisfying those in quest of information as to original sources and books of reference. From both points of view it has much to recommend it; it will leave the general reader with a clear idea of the main outlines of the subject, while the student will find in it a painstaking and, within certain limits, a trustworthy guide. We are inclined to prefer the chapters dealing with Celtic literature in modern times, with the Highland bards before the Forty-five, with the master gleaners of Gaelic poetry, &c. The pages which describe the influence of Celtic on English literature are also interesting reading. The book ends with a survey of Celtic studies and a list of Celtic scholars past and present.

WEATHER INFLUENCES.

Weather Influences: an Empirical Study of the Mental and Physiological Effects of Definite Meteorological Conditions. By Dr. E. G. Dexter. Pp. xxxi+286. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) Price 8s. 6d. net.

THE effect of changes of weather on human activities has been the subject of much discussion, and each of us has no doubt formed an opinion on how he individually is affected by different meteorological conditions. The problem as affecting the behaviour of humanity in the mass has, however, received but scant attention hitherto. The statistical method affords the means of obtaining numerical results which enable us to estimate the importance of such effects.

Meteorological statistics are nowadays available from most centres of population; social statistics are also plentiful, yet of these only a limited number can be made to yield information on the general conduct or the working capacity of the community as a whole. In the book before us Dr. Dexter has collected and discussed sixteen classes of data culled from school records, covering both questions of attendance and conduct, police records dealing with cases of assault, drunkenness, murder, suicide, arrests for insanity, discipline in penitentiaries and the health of the force, the death register, registers of attendance in the out-patient departments of hospitals, and records of the number of clerical errors discovered in the books of certain banking establishments. The latter are the only data studied which deal exclusively with mental activities. All the records refer to New York City or to Denver, Colorado. The meteorological statistics with which they have been compared were obtained from the U.S. Weather Bureau.

The effects of seasonal changes are first discussed, and then the influence of each of the meteorological elements is considered separately. The general method of arranging the material for this purpose will be clear from the following description of that of dealing with the connection between temperature and assault. The days falling within the period considered were arranged in groups according to their mean temperatures, each group extending over a range of 5° F. On the assumption that temperature has no effect on assault, the number of days in each group is proportional to the "expectancy" of assault for that group. The actual number of occurrences of assault on the days of the group is computed as a percentage of the "expectancy," and curves have been drawn using the "occurrences" as ordinates and temperatures as abscissæ.

In dealing with the element rainfall the usual meteorological distinction has been drawn between days of rainfall, on which 0·01 inch of rain or more was measured, and dry days. It seems a pity that a further subdivision was not made. Most of us would be inclined to draw a wide distinction between showery days with only a few hundredths of an inch of rainfall and days of steady downpour. Even if such a further subdivision had been adopted, days with a few heavy showers would not be distinguishable from days of continuous fall; probably a classification on the basis of duration rather than amount of rainfall would yield results which would repay the labour involved in tabulating the records of self-registering rain gauges.

The majority of the curves show fluctuations which are greatly in excess of any which could be due merely to accidental variations. The number of data is in some cases extremely large (about 40,000 cases of assault), and there can be no doubt about the genuineness of the effects of meteorological changes.

The interpretation of the results is, however, a matter of considerable difficulty, and the possible influence of other than meteorological causes has to be steadily borne in mind. The general line of argument adopted regards the curves as compound functions of "irritability" or "emotional state" and "available" or "reserve energy." Thus, to return to the temperature-assault curve, we find a marked deficiency of occurrences at low temperatures. This has been taken to mean that under these conditions so large a portion of the vital energy is used up in supporting normal metabolic processes that the surplus available for active disorder is small. Under warmer conditions our pugilist, in addition to being more out of doors and thus seeing more of his neighbour, has more reserve energy available for active warfare, and the work of the police is proportionately increased. Above 65° the curve commences to rise with increased rapidity. Fighting energy is now at its prime, and at the same time "irritability" or quarrelsomeness is rapidly increasing. The temperature group 80°–85° shows a conspicuous maximum in the relative frequency of assaults. In the next group, 85°–90°, the curve exhibits a sudden drop. Irritability may very possibly be at a maximum, but the energy necessary to commence war is lacking, and a mere desire to fight is not a punishable offence. It is an interesting fact that the curve for women shows the above effects even more conspicuously than the one for men. A similar accentuation of the general characteristics is shown in all cases in which the number of data is sufficiently large to justify a separation of the sexes, so that it would appear that women are, on the whole, more susceptible to weather influences than men.

Some of the most interesting and at the same time most inexplicable curves are those which show the effect of the height of the barometer on human activities. With a few exceptions all classes of data show a marked excess of occurrences for periods of low barometer and a corresponding deficiency when readings are high. We cannot set this down to the direct effects of the diminution of pressure on the human organism; crime, &c., does not increase with altitude. Attempts at explanation by calling to our aid the usual accompaniments of a low barometer, viz. wind, rain, or cloud also fail, for when the effects of these elements are considered separately we find that in a number of cases the results contradict the hypothesis. Dr. Dexter directs attention to the peculiar "feel" which some people have for the approach of a storm, but this hardly amounts to an

explanation. It has been suggested that the radio-active emanation which is always present in the atmosphere in varying quantities may not be without influence on the human organism, and if, as Elster and Geitel suppose, this emanation is mainly derived from the underground air, which is more copiously discharged into the atmosphere as pressure decreases, it may be possible to establish a connection between the "storm feel" and the presence of radio-active emanation. If this be so we should expect to find the effect more pronounced with a falling than with a rising barometer, and, in the absence of direct measurements of the amount of emanation, the results obtained from a classification of the days, or perhaps better still, by a subdivision of the data used in constructing the present curves, on this principle would probably be interesting. Such a separation might prove profitable from a purely meteorological point of view, apart from all considerations of emanations, radio-active or otherwise. Possibly the peculiar abnormalities shown by most of the data for days of calm may be to some extent due to similar causes. The connection is, however, a very complicated one; attempts to trace a similarity between days of calm and days of low barometer fail signally.

We cannot here enter into a discussion of all the results or criticise the individual conclusions arrived at. In the final chapter Dr. Dexter further develops his thesis of the "available energy" and "emotional state" in the light of all the accumulated evidence, and comes to the conclusion that the effect of weather changes is greater on the former than on the latter, at any rate in its practical effects on conduct.

The study of the problems dealt with in the book is not without a certain practical interest to all who are responsible for the control of large numbers of individuals. If certain meteorological conditions can be shown to have a deleterious or beneficent influence on conduct or working capacity, it is well that we should recognise the fact as clearly as possible, and do what we can to mitigate the harmful conditions. Man cannot hope to control the weather, but he can modify the highly artificial conditions under which he lives to a very large extent.

A LIMNOLOGICAL MONOGRAPH.

Le Leman, Monographie Limnologique. By Prof. F. A. Forel. Vol. iii. Part ii. Pp. 410–715. (Lausanne: F. Rouge et Cie., 1904.)

IN the issue of this, the second part of his third volume, Prof. Forel completes his great monographic study of the Lake of Geneva. The veteran pioneer of scientific limnological research is to be congratulated on the successful termination of his monumental task, commenced some half-century ago.

The impetus which the study of lakes has received from the labours of Forel has now carried us so far that we find it difficult to realise the arduous nature of the work accomplished by him, who had in so many different directions to make the first tentative trials of methods of research with which all students of limnology are now familiar. The completed work is not merely a compendious study of the Lake of Geneva, but is besides of the utmost value as a general study of the nature of fresh-water lakes. In his painstaking study of this one lake he has been so fortunate as to observe and explain in a satisfactory manner many phenomena of general scientific interest and importance, among others the mysterious rise and fall of the waters of the lakes now known as seiches, the peculiar abyssal fauna of the lake, &c.

The present part of the work, which is mainly historical, deals with such varied subjects that it is difficult to particularise. Nothing having the slightest connection, direct or indirect, with the Lake of Geneva is destitute of interest for Prof. Forel, and we find here discussed many questions which a less enthusiastic limnologist might have been content to leave to students of other departments of knowledge. He gives a *résumé* of the history of the surrounding countries, of legislation, the fluctuations of population, local traditions, &c. More particularly apposite to the subject are the history of the lake dwellings, undertaken fifty years ago, in company with a band of archæologists of which he laments that he is the only survivor, the history of navigation, of fishing, and of pisciculture.

The history of navigation is treated very fully, from the canoe of the lake dweller to the modern steamer, and is illustrated with reproductions of many ancient pictures of ships; with such fulness of detail is the subject treated that we have a list of steamers plying on the lake from the *Guillaume-Tell* of 1823 to those of the present day.

The ancient tradition of the "éboulement du Lauredunum" is discussed in its scientific bearings. The tradition, supported by contemporary chronicles, is that in the year 563 A.D. a mountain was precipitated into the lake, destroying a castle, villages and churches, causing a flooding of the shores of the lake, and much destruction of property and life in Geneva. He shows that a landslip, such as has occurred several times in history, could not account for the production of great floods. Although he has abandoned the belief that earth movements habitually produce seiches, he admits that a great earthquake might be the cause of the land-slide, and coincidently of a great seiche, which would cause destruction on the shores of the lake. He thinks it more probable, however, that at a time of ordinary flood, when the waters of the lake were very high, an ordinary seiche of no more than a metre of amplitude might cause considerable flooding in Geneva, and perhaps wash away some wooden bridges and houses, the connection with the landslip being a mere coincidence.

In his philosophical reflections at the conclusion of his work, Prof. Forel claims that there have been few problems presented to him in the course of his investigations which he has not been able to solve, and the more difficult of these few are general problems, not belonging to his special province, and the solution of which must be sought in other lakes. He would, however, guard against this assertion being misunderstood as a boastfully complacent assumption that he has exhausted the subject. Every naturalist has his limits, determined from within by the extent of his powers, from without by the state of the

sciences in the age in which he lives. What is accomplished in one generation is the foundation for the achievements of the next.

That the subject is not exhausted we may easily see by remarking the progress that has been made in one of its departments most easily reviewed, since Prof. Forel finished that part of his work. In biology, even in the simple cataloguing of the lacustrine animals and plants, it is obvious that the work accomplished under his guidance is no more than a beginning in this direction, and specialists in any branch find abundance still to do. It is with no intention of belittling the work of Prof. Forel that this aspect of the subject is adverted to. It is a great work patiently carried through, and will serve as a foundation for all future limnological studies.

HENRY SIDGWICK'S ESSAYS.

Miscellaneous Essays and Addresses. By Henry Sidgwick. Pp. vii+371. (London: Macmillan and Co., Ltd., 1904.) Price 10*s*. net.

IN this volume we have the first instalment of the shorter essays of that brilliant thinker, Henry Sidgwick. They have been chiefly collected from journals and reviews, but two are now published for the first time. His philosophical lectures and papers are reserved for a companion volume. In a way, the selection of articles now before us illustrates a period of thirty-six years of the life of one of the most striking personalities of our time, and on that account, and from their breadth of view, they have a value even though the occasion of their appearance is long past.

Of the sixteen papers, six are literary or critical, six deal with questions of socialism and economics, and four with education and university affairs. We were surprised and somewhat disappointed to find no reminiscence of his activity in connection with the education of Englishwomen, but perhaps more may be expected when the histories of Newnham and Girton come to be written.

A detailed review of the essays on Shakespeare, Matthew Arnold, and Clough, or of those on political economy or sociology, hardly falls within the sphere of this Journal, but few of our readers who are interested in the burning question of the best education for men of science will regret having read Sidgwick's essay on "The Theory of Classical Education," reprinted from F. W. Farrar's "Essays on a Liberal Education," which was originally published in 1867. In the light of the recent controversy on the Greek question much of this excellent paper reads as if it had been written yesterday, and it is difficult to avoid the reflection that if several of the writers of controversial letters to the *Times* had read this essay of forty years ago, both their matter and manner might have been improved.

With respect to the classical element in a scientific education, Sidgwick was of opinion that although science had at length broken its connection with what was so long the learned language of Europe, yet everyone who aspires to become a "learned" man of science will require to read Latin with ease, but that the sole stock-in-trade of Greek necessary for him would be a list of words that he could learn in a day and the use of a dictionary that he might acquire in a week. In other words, he appeared to be in favour of the retention for the highest class of science students of that modicum of Greek which is at present compulsory at Oxford and Cambridge, only he would perhaps have liked to see it reduced and treated as a distinct part of the direct teaching of English.

A clear distinction is drawn between natural and artificial educations, and between the effects of literary and of scientific training. With regard to the latter Cuvier's famous remark is quoted with approbation:—

"Every discussion which supposes a classification of facts . . . is performed after the same manner; and he who has cultivated this science merely for amusement, is surprised at the facilities it affords for disentangling all kinds of affairs."

He admits that a student of languages could not honestly claim an analogous advantage for his own pursuit. The editors are justified in the inclusion of the essay on "Idle Fellowships" in spite of the fact that the evils of which it complains have greatly diminished. The general educational considerations discussed are of so wide a bearing that they are not less true now than in 1876, when the essay was published.

We feel certain that those who peruse this volume will share our gratitude to the editors for their share in the re-publication.

OUR BOOK SHELF.

The Insulation of Electric Machines. By H. W. Turner and H. M. Hobart. Pp. xvi+297. (London: Whittaker and Co., 1905.) Price 10*s*. 6*d*. net.

THE perfecting of the modern dynamo electric machine, and the necessity of high potential differences have within recent years quite altered our ideas about insulation. Electrical engineers have come to view the subject from a different standpoint on account of the importance of disruptive strength of the material apart from conduction pure and simple. The book under review appears at a very appropriate time. Our knowledge of the physical properties of insulators is now sufficient, and the want of a really good book on the subject is great enough to justify its appearance. It will be welcomed by the electrical engineer as a most valuable addition to his library.

The book opens with an account of the requisites for insulating materials, and the most perplexing phenomena met with during the testing of the same. Why is it that air has comparatively such low dielectric strength, and yet it is a very good insulator as ordinarily understood? Again, why does the apparent dielectric strength per unit thickness of such a substance as mica vary with the thickness? These and many other matters difficult to understand are laid before the reader. The properties of insulating materials and the influences of temperature and moisture upon them are next dealt with. The authors quite rightly lay stress upon the testing of insulators at, or even exceeding, their working limits of temperature, and the futility of baking to obtain temporary insulation unless moisture be permanently excluded. When dealing with the influence of brush discharge mention might with advantage have been made of the production of nitric acid, and the ultimate

breaking down of the insulation. The production of ozone—the forerunner of the above effect—is a matter of the utmost importance to electrical engineers, especially in damp climates.

That portion of the book dealing with varnishes is most valuable. The pros and cons. of the use of linseed oil, which undoubtedly has a very extended use at the present time, and other acid bodies are well set forth, as are those of the use of insulators of paraffin origin. The uses to which oils can be put as insulators, their various characteristics, their purity and methods for purifying and drying are carefully dealt with. Presspahn-mica is advocated instead of micanite for high tension working.

An important part of the work is that which deals with insulation of armatures, field-coils, and transformers. It is well shown upon what the so-called "space-factor," that is the ratio of area of copper to gross area of slot, depends. Very valuable suggestions are made with regard to pressure tests. Long time high pressure tests are likely to injure apparatus, and are not recommended—a few seconds' application is sufficient. The appliances in use for taping and handling insulation material, and a most interesting description of the tools employed, together with a useful bibliography, close what is really a valuable book. The printing is good, and the illustrations are excellent. ERNEST WILSON.

Insect Life. A Short Account of the Classification and Habits of Insects. By Fred. V. Theobald, M.A. With numerous illustrations (53 in the text). Second edition, revised. Pp. xi+235. (London: Methuen and Co., 1905.) Price 2*s.* 6*d.*

THE first edition of this work was published in 1896, and the public interest in entomology is evidenced by the increasing number of books on the subject which reach a second edition within a comparatively short time of publication. A cheap popular illustrated book on insects seems at present to be assured of a sale at least sufficient to cover expenses, which was not the case a few years ago.

The second edition is exactly similar to the first as regards its size, illustrations, and general contents; but here and there we notice occasional additions. There is much useful information in the book, but we regret that the second edition has not been more carefully revised, for, apart from occasional misprints, several erroneous or obsolete statements contained in the first edition have been repeated in the second. Thus on p. 3 (note) we read, "The total number [of insects] described, however, is under 250,000." This is probably based on Kirby's estimate in his "Text-book of Entomology" (1885) of 222,000; but the later estimate given in the second edition (1892) was 270,000, which would require to be augmented by many thousands to be correct for 1905. On p. 87, "The so-called Apples of Sodom found near the Red Sea," should, of course, be the Dead Sea. While it is true, as stated on p. 105, that *Danaus chrysippus* is the only European species of the genus, the much larger insect occasionally found in England is the common North American *D. erippus* (or *D. archippus*), introduced, but which may not improbably become naturalised in Europe, and has established itself within the last half-century in many of the Pacific Islands, as well as in Australia and New Zealand. Lastly (p. 166), it is possible that the bite of the species of tsetse fly which destroys cattle in South Africa may be "comparatively harmless to man"; yet, as Mr. Theobald must certainly know, the terrible sleeping sickness of Western and Central Africa is now ascribed to the bites of different species of tsetse flies infesting those regions.

We hope that when this little book reaches a third edition Mr. Theobald may have an opportunity of enlarging it, for entomology, like other sciences, advances so rapidly that it is not possible to bring it up to date, unless the author gives himself a free hand in this direction.

The Radial Area-Scale. Patented by R. W. K. Edwards. (Richmond, Surrey: Morgan and Kidd.) Price 3*s.* 6*d.*

THIS ingenious instrument is designed for use in finding the approximate areas of irregular plane figures such as indicator diagrams. It consists of a sheet of transparent celluloid marked with eleven scales on lines radiating from a point at equal angular intervals of about 3°, and so divided that a scale reading is proportional to the area of a sector from the centre up to that point. When used, the sheet is laid over the figure to be measured, and is adjusted until the figure is just contained within the bounding radials, with its outline cutting the nine inner scales each in two points. The outer and inner readings at these points are now taken and the two sets added; the difference between the two sums gives the required area. The entire operation occupies about three minutes. Applied by the writer to a 3″ circle and a 6″ semicircle, the results were correct in both cases to within $\frac{1}{4}$ per cent. As the outside radials include an angle of about 30°, the instrument is quite quickly adjusted over large or small figures of any shape, and the scales are clear and easy to read. To ensure a good approximation, Simpson's rule has been cleverly applied in figuring the scales. The instrument seems likely to be of considerable service, and should be widely known.

A Preparatory Course in Geometry. By W. P. Workman and A. G. Cracknell. Pp. viii+56. (London: W. B. Clive, 1905.) Price 9*d.*

THE little book by Messrs. Workman and Cracknell is preparatory to a forthcoming work on "Geometry, Theoretical and Practical," on which the authors are now busily engaged. It consists essentially of a set of exercises on the accurate scale drawing of lines, angles, triangles, and polygons, and requires the reading off of quantitative results as regards lengths and angles. Areas, ratios, and the general properties of circles are not reached in this volume. It trains the youth in the proper use of the drawing-pencil, straight-edge, scale, protractor, set-square, and compass, and gives him a concrete knowledge of, and practical insight into, geometrical truths as a preliminary to more formal work. Teachers using the book would do well when valuing class work to act on a suggestion contained therein, and give varying credit according to the degree of accuracy disclosed by the results. The book gives good promise of another very interesting class book of elementary geometry.

The Evolution of the World and of Man. By George E. Boxall. Pp. xi+191. (London: T. Fisher Unwin, 1905.) Price 5*s.*

A SINGLE example to show how Mr. Boxall proposes to supplement the deficiencies in the story of evolution as told by science will enable possible readers to estimate the value of his book. On p. 30, after stating that geology tells us the order in which various strata were laid down, he continues:—"but no attempt has as yet been made to estimate the temperature, for instance, when the granite was first deposited, and yet this should not be a difficult problem to solve. Thus, of the true metals, aluminium is the only one which appears in the granite, . . ." and the account continues with the same disregard of scientific fact. Mr. Boxall expresses his own view of the value of the book by not troubling to provide an index to it.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Possibility of Reducing Mosquitoes.

IN his able review of James and Liston's interesting "Monograph of the Anopheles Mosquitoes of India," published in your issue of May 25, Dr. Stephens recapitulates the arguments of these authors in favour of their hypothesis that "the task of materially reducing the number of Anopheles in any place will undoubtedly be one of great magnitude." As the subject is one of the greatest sanitary importance, it may perhaps be advisable to add that the validity of these arguments is by no means accepted by all students of the subject. They are based for the most part on the results of some anti-mosquito work done at Mian Mir by Dr. Christophers and Captain James. Perhaps those of your readers who are not medical men may not be cognisant of the fact that an exhaustive and, I think, destructive criticism of this work has been published by Colonels Crombie and Giles, Captain Sewell, and myself—*vide British Medical Journal*, September 17, 1904, and *Journal of Tropical Medicine*, 1904. My own conclusions were that the operations cost too little to be effective, and that no exact method was employed for enumerating the numbers of mosquitoes present before and after their commencement. So far as I am aware, Dr. Christophers and Captain James have not replied to our criticisms, and I therefore feel justified in assuming that the case has gone against them by default. I should add that I hear on very good authority that the operations at Mian Mir are now being continued on a better basis.

The principal argument of our authors appears to be that the local reduction of mosquitoes will be wholly or largely impracticable because of immigration of the insects from outside. Thus they mention four methods by which Anopheles are dispersed, namely, by flight, by streams, by carriages, and by gradual spreading in all directions "by short stages," and think that the last method is "overlooked by those who have no intimate knowledge of mosquito habits, but who readily draw up schemes for their wholesale destruction." I fear that these very self-evident facts were well known and carefully considered long before the authors commenced their researches, and, moreover, that they do not by any means establish their case. It is quite obvious that a considerable number of mosquitoes must always find their way by diffusion into any area of operations; but this is not enough. What the sceptics have to prove is that the number of immigrants must be so large as nearly, or completely, to compensate for the local destruction. This is quite a different proposition, and one which will, I think, tax their ingenuity to maintain. If the local mosquito-density is to remain the same in spite of local destruction, it can only be by means of an abnormally large compensatory immigration setting in coincidentally with the commencement of the work of reduction. But what is there to determine such an extraordinary and suicidal influx? Mosquitoes do not, like a gas, exist under a pressure which compels them to fill up a vacuum, and we can scarcely suppose that they voluntarily move in the direction of their own destruction. But, even if they do rush in to fill the local vacuum, they must, in order to do so, forsake the outlying tracts of country (which will be correspondingly benefited by their absence), so that the total average reduction over the whole area influenced by the operations will be exactly the same whether migration takes place or not—an argument which appears to have been overlooked by the sceptics.

Owing to the fact that the to and fro movements of all random wandering must tend to annul each other—that is, that the vectorial sum of such movements must tend to zero—I think that migration is not likely seriously to counteract the effect of anti-propagation measures. I should like to refer those interested in this part of the subject to a paper by me, published in the *British Medical Journal* for May 13, in which I have endeavoured to approach the subject analytically. My results agree with those of the late Mr. Ronald Hudson, who kindly commenced a similar analysis for me shortly before his lamented death, and also, I may add, with general experience, which shows that though a few mosquitoes may occasionally wander to considerable distances, the large bulk of them remain near their breeding pools. I venture to think that those who would prove the converse must do so, not by citing individual cases of long wandering, but by making a much more exact numerical determination of the amount of immigration than they have yet attempted, and by showing that it greatly exceeds the local birth-rate—a somewhat difficult task. That their observations are not always those of others may be seen from the following quotation from Dr. Malcolm Watson's report on the highly successful anti-malaria measures carried out in the Federated Malay States (*Journal of Tropical Medicine*, April 1, p. 104):—"A definite improvement in the health of Klang was evident when only the swamps nearest to the main groups of houses had been dealt with, and while other swamps within the town were still untouched. The mosquitoes from these did not appear to travel any distance, and there has been no evidence of dangerous immigration of Anophelines from the extensive breeding places which until the middle of 1904 existed just outside the town boundary, and some of which still remain."

So far as I can see, the case must be the same for mosquitoes as for most other organisms, including man. We should be very much surprised if anyone were to maintain that the population of the British Isles, for instance, would remain the same after abolition of the birth-rate. Why, then, should we assume such a proposition for mosquitoes? RONALD ROSS.

The Romance of the Nitrogen Atom.

THE letter of Dr. F. J. Allen (NATURE, May 4) on the critical temperature of living substances has interested me immensely. The ideas contained in it have often presented themselves to me in a crude way, and I hope Mr. Allen will find opportunity for elaborating them. I have often thought, when pondering over what one may venture to call the *versatility* of nitrogen, that a useful book might be written on the chemistry of the nitrogen compounds, including the mineral and organic compounds of that element in one view. If it did no other service it would help to save the mind of the chemical student from being enslaved by the phrase, "the chemistry of the carbon compounds." If the phrase "Ohne Phosphor kein Gedanke" is true, may we not with equal truth say "Ohne Stickstoff kein Leben"? The marvellous powers stored in the carbon atom are sufficiently *en evidence* in chemical science; yet may we not recognise the nitrogen atom as the magic "demon" (borrowing a figurative term from Clerk Maxwell) that holds the wand, that (under given conditions such as are noted by Dr. Allen) turns the atoms of oxygen and hydrogen hither and thither in the multiplex atomic relations of growth and metabolism in the living organism, and especially in that little understood complex we call chlorophyll? We know that the inert N_2 molecule of the atmosphere is made up of atoms which, in the nascent state, are possessed of great chemical energy, and we may fairly, I think, explain the inertness of ordinary atmospheric nitrogen by the stability of its molecule (N_2) as arising out of a difference in the ionic constitution of the two atoms which form the molecule. Is it not here that we may seek for the explanation of the otherwise puzzling fact that in the extremely stable compound NH_3 the nitrogen atom is trivalent, while in the oxides, halides, &c., it is pentavalent? The action of the nitrogen atom, in the way suggested by Dr. Allen, is illustrated by the well known necessity in the fertilisation of soils for the conversion of NH_3 into nitrates of alkaline bases, in order that the nitrogen in a *more unstable state of combination* may do its special work in the internal economy of the plant. I recollect discussing this matter some years ago with Dr. Voelcker, when I had the pleasure of meeting him at an agricultural gathering in this neighbourhood. The modern idea of ionisation of atoms seems also to throw light upon the fact that N_2

and H_2 combine to form NH_3 under the influence of the silent electric discharge, while at the temperature of the spark-discharge NH_3 is again split up into N_2 and H_2. The running down also of HNO_3 through the whole series of oxides into ammonia in the Grove cell is full of interest from this point of view, and the subject, with its manifold ramifications, is a fascinating theme for a thesis.

Bishop's Stortford, May 30. A. IRVING.

An Inverted Slab in a Cromlech.

THE remarkable articles on Stonehenge and other monuments by Sir Norman Lockyer have naturally stimulated reflection upon all that concerns megalithic remains, and therefore, perhaps, the following curious circumstances may be of some interest.

At Henblâs, in Anglesey, is a cromlech, or rather, I suppose, a dolmen, of remarkably rude and massive aspect. Two uprights remain, the larger of which is about 15 feet high by 9 feet thick, and both are very rough and irregular in shape. Resting against these, at an angle of about 20° or rather less from the horizontal, is a thinner stone, about 3 feet thick and some 13 feet square, presumably a top-stone. All are of a hard quartzite, which occurs among the schistose rocks of the district. No good exposure of this is known within a mile or so of the cromlech (a fact which Captain Evans, of Henblâs, informs me was pointed out to him long ago by Sir Andrew Ramsay). But at the base of the uprights are some obscure exposures that appear to me to be *in situ*, and I am inclined to think, therefore, that the materials were obtained on the spot.

Now the supposed top-stone is rough, like the uprights, on its upper surface, but its under-side is beautifully and finely ice-worn! It is clear, therefore (for it is certainly not a boulder), that it has been turned upside down.

Further, not only is it ice-worn, but the *direction* of the ice-movement can be made out, there being distinct lee-sides to its finely striated bosses, and these lee-sides look to N.N.E. But the natural direction of glaciation in the district is to S.S.W. Therefore, the stone has not only been turned upside down, but turned round as well.

If the materials were brought from some distance, these facts are, of course, of less interest. But if, as I think much more probable, they were obtained on the spot, it is clear that they throw a little light upon the proceedings of the builders in their work of lifting these great stones.

Achnashcan, near Bangor. EDWARD GREENLY.

The Cleavage of Slates.

I FIND that I owe Mr. Fisher some apology for a carelessly worded allusion in my notice of Dr. Becker's memoir (p. 20, May 4). In pointing out that the theory which I criticised had been anticipated by Mr. Fisher, I ought, perhaps, to have mentioned that the latter had somewhat qualified his original hypothesis, though the postscript notifying this qualification was, I believe, only privately printed.

Mr. Fisher's further contribution to the question (pp. 55, 56, May 18) is of interest. If it be granted that the cleavage of the Westmorland slates coincides with the plane of greatest distortion, it becomes less necessary to urge the case of the colour-spots in the Llanberis slates; but the suggestion that these have been formed subsequently to the cleavage seems to raise some difficulty. I have seen examples in which the ellipsoidal green spots are shifted by small faults, which are quite obsolete as planes of weakness. This seems to imply that the faults, and *a fortiori* the spots, are older than the cleavage-structure. ALFRED HARKER.

St. John's College, Cambridge, June 7.

The Inheritance of Acquired Characters.

Is the following an instance of such inheritance? Lately I heard a missionary at a May meeting tell of the marvellous facility with which Chinese children memorise whole books of the Bible; the four Gospels, and sometimes the Acts also, being an easy feat for children of ten or twelve years. Having carefully sought information from other authorities, I find these facts confirmed, and that the same applies to Mohammedan children. We are aware that for ages their ancestors have been compelled to memorise long portions of their sacred books, and although occasionally we meet with a child of any nation with a gigantic memory, that differs widely from the case of a people where it has become a general characteristic.

June 7. W. WOODS SMYTH.

THE UTILITY OF AN ANTHROPOMETRIC SURVEY.[1]

THE Government which has shown so scientific a spirit as to create a Council of Defence, a constant spirit of intelligence to safeguard the Empire amid the development of armaments of other nations, might surely devote attention to that recommendation which stands first in the report of the interdepartmental committee on physical deterioration:—"With a view to the collection of definite data bearing upon the physical condition of the population, the committee think that a permanent anthropometric survey should be organised as speedily as possible. . . ."

What are the results to be expected from such a survey as was sketched out at the Cambridge meeting of the British Association last summer? An improvement in the education of the people will surely follow.

At the time of the Elementary Education Act, 1870, the re-distribution of the populace, that progressive change by which the increasing majority become citizens and cease to be country folk, was not realised. The increasing demands of intellectual exercises upon the time of the children and loss of domestic education were not foreseen, or their effect in making the requirement most urgent that the physical side of education should be brought under educational authority or otherwise definitely provided for. Hence a generation passes and there is an outcry for physical education. Let us hope a coming generation may not be crying in turn that the moral side of education suffers from want of due attention.

The effect of registration—the national survey of deaths—has been a clear guide and a very great safeguard to the public health. One may quote some of the words of Dr. Farr which are to be found in his first letter to the first annual report:—"Diseases are more easily prevented than cured, and the first step to their prevention is the discovery of their exciting causes"; again, "indirect influence (of these reports) upon practical medicine must have been very great. The constant endeavour after exactness of diagnosis and precision of nomenclature is itself a wholesome discipline, which reacts inevitably upon treatment." Who at that time could prophesy the value, topographical and historical, we now find in these reports?

The anthropometric survey will have upon the sphere of education an equally large and discriminating, if often indirect, influence; it will react upon medicine as well as upon education; it will detect any deterioration of the young adult that is due to the factory and workshop; it will determine the influence of environment upon physique, and, as Mr. John Gray says, "without an anthropometric survey, we are in this important question of sound national physique 'like a log drifting nowhere'; with a survey, we should be like a ship, steering by chart and compass to its destination."

In the influence of body and mind upon one another, it is to anthropometry we must look for certainty of judgment. Mr. H. G. Beyer pointed out to the

[1] Physical Deterioration; being the Report of Papers and Discussions at the Cambridge Meeting of the British Association, 1904, on the Alleged Physical Deterioration of the People and the Utility of an Anthropometric Survey. (Occasional Papers of the Anthropological Institute, No. 2.)

American Association for the Advancement of Physical Education how important it was to make a study of "fatigue" in its relation to training and education, to find out the conditions under which our work has its maximum beneficial effect, and the limits to the exercise of our muscles favouring the performance of intellectual work. From data worthy of credence, he was of opinion that brain work influenced favourably bodily development, as well as *vice versâ*.

The basis of these and similar observations requires to be broad, and it was interesting to note at the Cambridge meeting how the want of the proposed survey was evident to nearly every speaker. Prof. Cunningham has pointed out how changed conditions of life are palpably attended by changes of physical standard, but we have no clear knowledge of these changes, the best facts concerning our country being still those collected five-and-twenty years ago by the anthropometric committee of the British Association. The racial substitution of a dark element for a fair in the population of London, noted by Dr. Shrubsall as an outcome of his investigations on hospital inmates and healthy individuals, demands a survey to determine its extent and nature.

In the remarks upon deterioration, made at the Cambridge meeting by the president, Mr. Balfour, this requirement stands out quite plainly again in his expression of opinion that fresh air has so large an influence upon the physique of the race.

That a knowledge of the conditions of respiration in towns is at the present day of eminent importance is also patent to everyone who may read, in a recent report of the Registrar General, that in the urban districts of England the death rate from respiratory system diseases is no less than double that of the rural districts.

Now while much attention has been paid to the air of schools and buildings, we have no knowledge whether the lung movement—the chest expansion—of the town dweller is much less than the countryman's, and the answer of a survey to this question is highly desirable. It may be that want of exercise of lung is a deteriorating influence like bad quality of air.

Now that a practical scheme of anthropometry with a responsible recommendation of such a scheme lies before our legislators, concerning a matter absolutely beyond the reach of private effort, surely the nation cannot afford to despise such knowledge, nor is the day past when this country can give a lead in the organisation of information to aid the public health.

Unlike Sweden, Germany, and Italy, we have no conscripts to form a source of similar information. The methods proposed are simple:—height, weight, chest girth; head-length, breadth, and height; breadth of shoulders and hips; vision and degree of pigmentation are to be measured. Economy and efficiency will be observed by the provision of whole time surveyors instructed at a single centre, and 80,000 adults and 800,000 children should be measured annually, re-visiting each district every ten years.

The eugenics of Mr. Galton are not at present practical politics, though, as an analogous subject, it is interesting to note that the stud books of hunters, shires, and hackneys have not only improved the breed, but raised the standard of health and improved the average of health in horses exhibited.

As to expense, the sum required is less than that spent on stud books, and similar to that of the Geological Survey. Provision is made, though not too liberally, for the survey of the land on which we live; surely it is not too much to ask that a scheme for the survey of the people should be established upon a national basis.

PHOTOGRAPHY AND NATURAL HISTORY.[1]

DRY plate photography cannot be altogether regarded as an unmixed blessing. The facilities which it affords to the amateur have brought down upon us a veritable avalanche of books on natural history subjects, some of which had better never have been written.

Mr. Snell's unpretentious little volume is, however, not of this number. On the contrary, it is of its kind excellent, and will prove a boon to those who are fond of nature-photography but, by force of circumstances, are unable to afford an expensive camera or to spend time and money in search of subjects far afield.

Commencing with a most useful chapter on the methods to be adopted in photographing living animals, the author, in the following chapters, demonstrates the practicability of the rules he has laid down. Small mammals, birds, reptiles, Amphibia, fishes, and insects are each, in turn, made to furnish illustrations. Finally, some very valuable hints are given on the photography of botanical subjects.

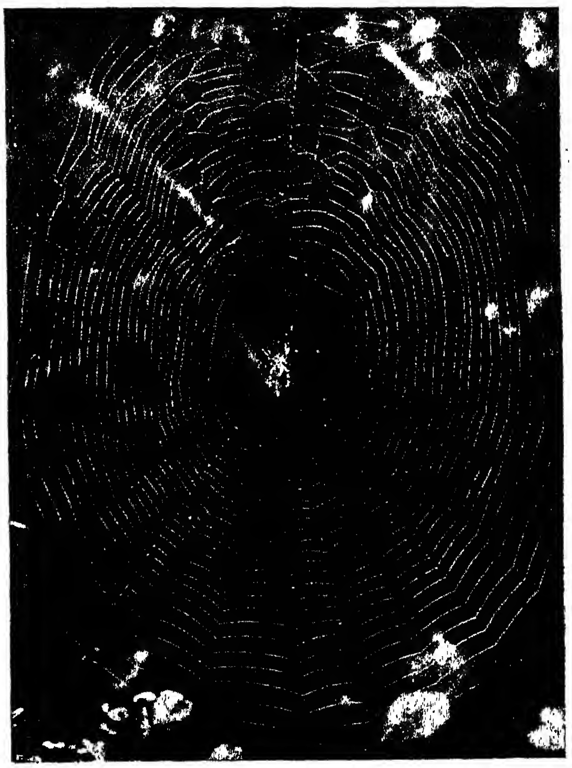


FIG. 1.—Spider's Web or Snare. From Snell's "The Camera in the Fields."

There are tricks, it is said, in every trade! This is notoriously true of photography. Some of the more harmless sort are lucidly described in this volume. The methods, for example, employed in the photography of mice and rats, snakes, and young birds will come as a surprise to many. Many of us, probably, have been amazed at the apparent skill and patience displayed by many "nature-photographers" in securing pictures of field-mice climbing wheat stalks, or rows of nestlings sitting peacefully along a bough. Such pictures, it now appears, may be

1 "The Camera in the Fields." By F. C. Snell. Pp. 256. (London: T. Fisher Unwin, 1905.) Price 5s.

secured in the privacy of a small back yard! It is only necessary first to catch your mouse. This done, he is penned in a glass cage and confronted by the camera. So soon as an attractive posture has been assumed, the exposure is made. A suitable background is all that is needed to deceive even the very elect!

Thus is the mystery explained of some of the wonderful pictures of "wild life with the camera" that have excited the envy and admiration of many who have sought, and sought in vain, in our fields and hedgerows to obtain similar pictures!

The illustrations in this book are unusually good and plentifully distributed. The specimen given herewith was selected with no little difficulty, inasmuch as the high standard of excellence, both in taste and execution, which these pictures present rendered choice difficult. W. P. P.

THE NATURAL HISTORY OF THE BAHAMAS.[1]

TWO years ago there was published in this country an account of a cruise to the Andaman and Nicobar Islands[2] by an American party for the purpose of obtaining natural history and ethnological specimens for the National Museum at Washington, and every Englishman worthy the name who read that work can scarcely have failed to experience a feeling of shame that it was not long ago anticipated and rendered superfluous by the enterprise of his own countrymen. If such a feeling exist in the case of a work dealing in a more or less cursory manner with the results of a private expedition to remote islands of little or no commercial importance, how must it be intensified when we find an American scientific society undertaking a systematic biological, geological, historical, and sociological survey of a group of islands which are supposed to rank among the more important possessions of the British Crown?

That the work should have been undertaken by American enterprise is, *ipso facto*, a confession that it required doing; in other words, that it ought to have been done by Englishmen, and the fact of its being left to our Transatlantic cousins is virtually an admission that our rulers—in spite of what we are being continually told as to the all-importance of science if we are to continue to hold our position as a nation—are blind to the needs and signs of the times in matters scientific! That we should have hitherto possessed no detailed and comprehensive account of a group of islands dotted over an area about as large as the British Islands, which has formed part of our Empire for generations, is, indeed, little short of a national disgrace, and the fact that Americans have cut in and done our own work for us in our own possessions speaks volumes as to the amount of attention that has been paid to the cry of "Wake-up, England!"

The contrast between our own apathy and American enterprise in scientific matters of this nature is intensified when we compare what is being done for the natural history of the Philippines by their new owners with what has been left undone in the case of the West Indies (and many other islands we could mention) by their ancient lords. We were about to urge our rulers, for very shame, to set about doing for the other West Indian islands what Americans have already accomplished for the Bahamas, but we fear we should only be speaking to deaf ears, and therefore refrain. Let us add that in all this we have not one spark of jealousy, but rather unbounded and respectful admiration, in regard to the work our American cousins have so successfully and so thoroughly carried out.

The trustees of the Geographical Society of Baltimore have, it appears, set themselves to accomplish two main objects by means of the body they govern, namely, in the first place, to furnish their public with an annual course of lectures connected with geography, and, in the second place, to foster geographical research in general, and from time to time to publish monographs dealing with some particular piece of geographical investigation carried out under the auspices of the society. The volume before us is the first of these proposed monographs, and its completeness and wealth of illustrations render it a more than usually striking and handsome example of American thoroughness.

The object of the expedition was to investigate the origin and natural history of the Bahamas, and also to conduct studies on lines intimately associated with the well-being of their inhabitants. The scientific staff included no less than twenty-four members, with Dr. G. B. Shattuck as director, most of whom are specialists in one or more particular departments, the special subjects of investigation being geology, tides, terrestrial magnetism and climatology, soils, botany, mosquitoes, fishes, other vertebrates, medicine, and history. Even this, however, by no means represents the full force employed in making public the results of the expedition, for many of the collections were handed over to specialists who did not accompany the latter, the reptiles and amphibians being, for instance, consigned to Dr. L. Stejneger, the birds to Mr. J. H. Riley, the mammals to Mr. G. S. Miller, and so on.

For months previous to the departure of the expedition, the director was engaged in equipping and organising its various sections, procuring the necessary apparatus, so that everything, even down to the most minute detail, should be in such a state of completeness that work might be commenced the very moment of arrival. The expedition sailed from Baltimore on June 1, 1903, equipped for a two months' cruise. Since a number of its members were in Government offices, from which they could only obtain leave during the months of June and July, the length of the cruise had been necessarily limited to that period, and every effort had consequently been made that work should progress with the greatest possible despatch during the time available. Unfortunately, bad weather was experienced during the outward voyage, so that Nassau, the first stopping place, was not reached until June 17, and as it was necessary to start on the return journey before the end of July, only about five weeks were left for work. The more southerly islands of the Bahama group had in consequence to be left unvisited; but apart from this omission, the greater part of the work which had been planned was brought to completion, and all the members of the staff are to be congratulated on the rapidity with which they executed their respective tasks. Except dredging and fishing, most of the work was done on shore, but all the field-work was, of course, merely preliminary to study in the laboratory. In examining the living products of the sea-bed—a sight of rare beauty—great advantage was derived from the glass-bottomed boat which formed part of the equipment.

Our statesmen should not fail to notice that, according to opinion in America, the construction of the Panama Canal in the near future (which is said to be assured) is destined to bring renewed prosperity to

[1] "The Bahama Islands." Edited by G. B. Shattuck. Pp. xxxii+630; 93 plates. [New York: The Macmillan Co.; London: Macmillan and Co., Ltd. (published for the Geographical Society of Baltimore), 1905.] Price 2l. 2s. net.

[2] "In the Andamans and Nicobars." By C. B. Kloss. (London: John Murray, 1903.)

the West Indies, and the hope is expressed by the editor that the facts recorded in the work before us "may be instrumental, if only in a small degree, in causing the Bahama Islands to share" in this prosperity. Commentary on this statement is superfluous.

The picture presented by the islands is well described in the following passage by the editor:—

"No words can describe the beauty of Nassau as one approaches the harbour from the sea. The ocean of deep sapphire suddenly changes to a lagoon of emerald green surrounded by shores of snow-white coral sand. Beyond, the white limestone houses of the town, intermingled with groves of graceful palms, and half-concealed by gorgeous poincianas, rise in a gentle slope against a sky of purest blue. The green transparent water; the intense blue of the sky; the blotches of blood-red poincianas; the snow-white drifts of coral-sand; the vivid green of the foliage—all these unexpected and yet harmonious contrasts strike the eye together, and stamp on the memory a picture of rugged beauty which nothing can efface. The impression thus received does not suffer when later the tourist wanders about the quaint old town to examine at leisure the details of the picture."

Our limits of space allow of only a brief reference to the details of the work of the expedition. An interesting and important feature connected with the geology of the Bahamas is that they are composed almost entirely of débris derived from corals and other calcareous organisms, and rest on a shallow, submerged platform, separated by deep ocean-troughs from the adjacent land-masses of North America and the West Indies. Few of the Bahama animals appear to be distinct from those of the mainland, although some of the mammals have been described (in earlier publications) as separate local races. Of some of these latter the skulls are now for the first time figured. An attractive feature of the volume is formed by the numerous coloured plates of marine Bahama fishes, which convey an excellent idea of the brilliant hues characteristic of all fishes which haunt coral-banks. Of especial interest is the plate of the "mouse-fish" or Sargasso-fish, the remarkable shape and coloration of which are doubtless developed to harmonise with its surroundings of floating seaweed.

This notice may be fitly brought to a close by the expression of our opinion as to the high value and importance of the work initiated by the Baltimore Geographical Society, and by the tendering of our congratulations to all those by whom it has been so successfully and faultlessly executed. R. L.

NOTES.

THE council of the Society of Arts has awarded the Albert medal of the society for the present year to Lord Rayleigh, "In recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

THE De Morgan medal of the London Mathematical Society has this year been awarded to Dr. H. F. Baker, F.R.S., for his researches in pure mathematics.

THE annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, South Kensington, on Thursday, June 29.

THE annual general meeting of the Society of Chemical Industry will be opened on Monday morning, July 10, at University College, Gower Street, when the president, Dr. Wm. H. Nichols, will deliver an address.

THE fourth International Ornithological Congress was opened by Prof. Oustalet at the Imperial Institute on Tuesday. Dr. Bowdler Sharpe, the new president of the congress, delivered an address.

THE death is announced of M. Edouard Simon, the eminent French engineer. He took an active part in the management of the Société d'Encouragement pour l'Industrie nationale, and contributed twenty-four papers to its proceedings.

AT the National Museum at Washington a series of specimens has been arranged to illustrate the associations and mode of occurrence of gold in nature, and Mr. George P. Merrill, the curator, has published in the *Engineering and Mining Journal* a useful list of associations represented in the collection. In the forty-eight cases enumerated, the gold occurs native, and in particles of sufficient size to be recognised by the unaided eye.

WITH the view of lessening the danger of lead-poisoning now encountered by diamond-cutters, the Dutch Government has offered a prize of 6000 florins for the most satisfactory substitute for the tin-lead alloy now used for holding the diamonds during the process of cutting. Applications, which may be written in English, should be sent before January 1, 1906, to Dr. L. Aronstein, Polytechnic School, Delft, Holland.

IN the Free Library at Hampstead there is displayed at present a selection from the collection of flint implements made by the late Mr. Henry Stopes. The exhibit gives a sample, not only of the whole collection, but of that part which deals with the ancient inhabitants of the Thames Valley, and it has been selected to interest the passer-by and educate his eye what to look for in his walks abroad.

Science announces that Dr. Franz Boas has resigned the curatorship of the anthropological department of the American Museum of Natural History. He will continue his connection with the museum, conducting the researches and publications of the Jesup North Pacific Expedition and of the East Asiatic Committee.

A REUTER message from Fort de France (Martinique) dated June 12 reports that Mont Pelée in the past few days has been displaying some renewal of activity. It is reported that on Saturday night, June 10, "the dome suddenly became illuminated. The dome collapsed on Sunday morning, and a mass of mud overflowed into the valley below, while a cloud of smoke rose to a height of 1000 yards."

THE departmental committee appointed by the Board of Agriculture and Fisheries to inquire into the nature and causes of grouse disease has made the following appointments:—Dr. C. G. Seligmann as bacteriologist to the commission, Mr. A. E. Shipley, F.R.S., as expert on the subject of internal parasites, Dr. H. Hammond Smith as assistant bacteriologist and additional field observer, and Mr. G. C. Muirhead as field observer.

THE Anthropological Institute of Great Britain and Ireland has arranged with Mr. J. J. Harrison to publish a full scientific report upon the physical and psychophysical characteristics of the pygmies whom the latter has brought to this country. For this purpose the council of the institute has appointed a select committee consisting of the following anthropologists and medical men, who, with the assistance of Mr. Harrison, will carry on the necessary investigations:—Sir Harry Johnston (chairman),

Prof. Arthur Thomson, Dr. A. Keith, Dr. W. H. R. Rivers, Dr. R. Murray Leslie, Prof. W. Gowland, Mr. J. Gray, and Mr. T. Athol Joyce.

THE committee of the Privy Council appointed to consider and determine certain points in connection with the establishment of a National Museum and National Library in Wales has decided that the two institutions should be separate, the National Museum to be established at Cardiff and the National Library at Aberystwyth. The support, local and otherwise, offered by Cardiff for the foundation and maintenance of the museum and library included:—(1) four acres at Cathays Park (20,000*l.*); (2) collections in municipal museum and art gallery (38,000*l.*); (3) a capital sum of (7500*l.*); (4) public subscriptions amounting at present to (32,500*l.*); (5) a ½*d.* rate under Museums and Gymnasiums Act, 1891 (1940*l.*); and (6) collections of books in municipal library (81,766 volumes and 9118 prints, drawings, &c.) (30,000*l.*).

DR. HENRY DE ROTHSCHILD (says the Paris correspondent of the *Chemist and Druggist*) has recently offered two prizes for competition which will be awarded next year. The first one is a prize of 200*l.* for the best work on the subject of the best alimentary rations of a child from its birth until the age of two years. The second one is a prize of 120*l.* for the best study on the supply of milk to a big city (hygiene, technology, transport, legislation, sale, &c.). These prizes may be divided should the jury of award consider it advisable. The competition is open to foreigners, and papers should be sent in before June 1, 1906. The secretary is M. C. Nourry, 49 rue des Saints-Pères, Paris.

IT was mentioned last week that the U.S. Weather Bureau is taking up the discussion of meteorological observations from the point of view of their relations to solar physics. The programme of the bureau with regard to the coordination of solar and terrestrial observations is, it may be noted, on the lines of the resolution of the Southport meeting of the International Meteorological Committee, which constituted a commission for the express purpose of that coordination. The commission held its first meeting at Cambridge last year, and will meet again at Innsbruck in September. Prof. Bigelow is one of the members, and there is no doubt that the work in this direction of the Washington Weather Bureau will be carried out in cooperation with the commission.

THE provisional programme drawn up and circulated by Prof. Hildebrandsson for the meeting of the International Meteorological Committee, referred to in the preceding paragraph, is mentioned in *Symons's Meteorological Magazine* (May). Among the subjects put forward for discussion are suggestions for improving observations which may be used for the comparison of phenomena over wide areas, especially with regard to noting the exact time of observing each instrument, reducing observations to standard conditions, and the like. Attention is to be directed to the very important question of the causes and the prognostics of widespread heavy rains, the importance of which as affecting floods is naturally felt much more on the Continent than in our country of mild extremes. Prof. Pernter is to suggest a more precise classification of meteorological stations according to the equipment and the nature of the observations carried on. The question of the possibility of extending the use of wireless telegraphy for obtaining reports from the eastern Atlantic, and many others on which an international understanding is desirable, will be taken up.

A LARGE portion of the March issue of the *Proceedings of the Philadelphia Academy* is occupied by the first portion of a paper by Mr. H. A. Pilsbry on the terrestrial molluscs of the south-western United States.

IN the *American Geologist* for April Mr. L. M. Lambe describes in detail, with an excellent figure, the structure of the cheek-teeth of a Canadian representative of the genus Mesohippus, one of the forerunners of the horse.

THE Perthshire Museum, which from the very beginning of its existence has devoted its energies to the illustration of the biology and physiography of the district, has just published an illustrated hand-book to the collection, which forms a short but excellent guide to the animals, plants, and rocks of the county. This is as it should be, and the museum is to be heartily congratulated on the line it has taken up.

IN the *Johns Hopkins University Circular*, No. 5, Mr. E. A. Andrews discusses the so-called *annulus ventralis* of the crayfishes of the genus Cambarus, and confirms the view that its function is to serve as a sperm-receptacle. It is, however, further shown that this structure, which is common to all the members of the genus in question, and is unknown in other crayfishes, is essential to reproduction, and if eliminated would lead to the extinction of the group. In the same issue Mr. R. E. Coker discusses Dr. H. Gadow's theory of orthogenetic variation among tortoises and turtles, and comes to the conclusion (from the examination of a very large number of specimens) that it is not confirmed by the evidence available.

FISHERMEN and fishmongers in Illinois appear to have been aware for some time of the existence of a shovel-beaked sturgeon belonging to a species unknown to science. Eight specimens of this white sturgeon, as it is called by the local fishermen, have, however, recently come under the observation of Messrs. Forbes and Robinson, by whom the species is described as the representative of a new genus, under the title of *Parascaphirhynchus albus*, in the *Bulletin of the Illinois Laboratory of Natural History* (vol. vii., art. 4). Its uniformly light colour, long small eye, long and narrow snout, bare under-parts, small and numerous plates, and superior number of ribs differentiate it sharply from the common shovel-beak or "switch-tail" (*Scaphirhynchus platyrhynchus*). About one specimen in 500 of the sturgeons taken at Grafton, Illinois, belongs to the new species.

THE occurrence of a layer of mesodermic tissue in the anterior part of the head of embryos of the laughing-gull forms the subject of an elaborate article by Mr. H. Rex in parts ii. and iii. of vol. xxxiii. of Gegenbaur's *Morphologisches Jahrbuch*. The occurrence of mesoderm in this part of the head of sauropsidan embryos is, it appears, a comparatively new discovery, and the laughing-gull was selected as a good subject for further investigations concerning this feature. Three articles, two by Mr. G. Ruge and one by Mr. P. Bascho, in the same issue are devoted to the discussion of the nature of certain alleged vestiges in man of the *panniculus carnosus* of the lower mammals, such as the musculus sternalis, and the so-called *achselbogen*. Much turns on whether the former of these muscles constitutes a superficial branch from the upper layer of the pectoral muscles, or whether it has no genetic connection therewith. The view that the structures in question are really functionless representatives of a skin-muscle is supported. In a fifth article Mr. E. Goppert discusses the last part of Dr. Fleischmann's studies on the cranial skeleton of the Amniota.

We have received the year-book for 1905 of the Livingstone College, which gives interesting details of the past year's work, experiences of past students from the mission fields in all parts of the world, and a few hints on risks to health in the tropics and how to avoid them.

The *Journal of the Royal Sanitary Institute* (vol. xxvi., No. 5, June) contains notes on minimum sanitary requirements for building bye laws by Mr. Searles Wood, on isolation hospitals by Dr. Davies, a lecture on canned foods by Prof. Kenwood, and other interesting papers, reviews, and notes.

The *Sitzungsberichte der kaiserl. Akad. der Wissenschaften* (Wien, Bd. cxiii., Heft viii. and ix., Abt. iii.) contains a paper by V. L. Neumeyer on intraperitoneal cholera infection in the salamander; this animal he shows is fifty to sixty times less susceptible than the guinea-pig, an extremely active phagocytosis taking place on injection of the microbe. Prof. M. Löwit contributes an exhaustive study of intravascular bacteriolysis.

Lieut. Christophers, I.M.S., in a third report (*Scientific Mem. Gov. of India,* No. 15), details experiments on the cultivation of the Leishman-Donovan body of kala-azar, a disease of Assam. Rogers and Leishman have obtained flagellated protozoa in cultivations of the parasite. Christophers corroborates this, and although the flagellated forms are very like Trypanosomata, he does not commit himself as to their exact nature.

A fourth fascicle of Mexican and Central American plants, described by Dr. J. N. Rose, and forming vol. viii., part iv., of the *Contributions* from the United States National Herbarium, contains several revisions of genera in addition to the enumeration of many new species. Synopses are provided for Mexican species of Ribes, Parosela, otherwise known as Dalea, and Heterocentron; the opinion that Œnothera is a polymorphic combination leads to the formation of a new genus Raimannia, concurrent with Hartmannia and Lavauxia, and several species of Ternstrœmia are collated under the name of Taonabo.

The Imperial Department of Agriculture for the West Indies has published the full report by Dr. F. Watts on sugar cane experiments in the Leeward Islands during the year 1903-4, and the results are presented in an abridged form in the pamphlet series Nos. 33 and 36. Reference has previously been made to the experiments with different varieties of canes, in addition to which manurial experiments have again been carried out. As the result of trials for four years the conclusion is arrived at that when, as is the custom, pen manure is worked into the soil, no advantage attends the addition of other artificial manures, and that phosphates may even tend to decrease the yield of plant canes. It has, however, been found advantageous to add nitrogenous manures to land planted with ratoon canes. The importance of nitrogenous manures is also affirmed by Prof. J. B. Harrison in his report referred to in the *Agricultural News,* May 6, which relates to sugar cane experiments in British Guiana.

We have recently received three circulars, Nos. 21, 22, and 23, also a bulletin, No. 55, from the Forestry Bureau of the United States Department of Agriculture. Circular No. 33, entitled "What Forestry means to Representative Men," contains extracts embodying the opinions of fifty experts, including President Roosevelt, regarding the value of scientific forestry. They all agree without exception that proper forest conservation is of vital importance to the welfare of the country. That the Department of Agriculture thoroughly realises this fact is shown by circulars Nos. 21 and 22, wherein is set forth the very liberal conditions under which practical assistance is given to farmers, lumbermen, and others in handling their forest lands, as well as the practical assistance offered to all tree planters. Bulletin No. 55, entitled "Forest Conditions of Northern New Hampshire," gives a detailed account of the condition, composition, and stand of timber in this region, with valuable suggestions as to the possibility of extended afforestation and the seemingly much needed forest organisation and conservation in New Hampshire.

The *Century Magazine* for June contains an interesting article by Mr. Gilbert H. Grosvenor entitled "Our Heralds of Storm and Flood," and gives a graphic description of the work of the U.S. Weather Bureau. The author rapidly reviews the whole of the useful operations of this service, but deals more especially with the predictions of floods, cold waves, and storm warnings. The cost of the Weather Bureau and its numerous branches is set down at one million and a half dollars yearly, while the amount of saving to property is estimated at thirty millions. One of the most remarkable cases of flood prediction cited was that of 1903, which was announced twenty-eight days in advance, after torrential rains extending over some 300,000 square miles. This flood caused terrible damage to property, but the public was prepared for it, and the loss was many millions of dollars less than it otherwise would have been. Much care is given to warnings of cold waves in early spring and autumn; the bureau aims at giving at least twenty-four hours' notice of their occurrence, and occasionally issues many thousand telegrams within a few hours. These blighting frosts sometimes destroy in one night the prospects of the agriculturist for the year. The storm warnings issued to the seafaring community form, perhaps, the greatest success of the efforts of the bureau. It is estimated that on the Great Lakes alone, the loss to shipping caused by storms has been reduced by 50 per cent. The article is beautifully illustrated with photographic reproductions of damage by floods, representations of clouds, and the freaks of tornados; the fact of straws, &c., being driven into trees can, fortunately, scarcely be realised in this country.

Messrs. Armbrecht, Nelson and Co. have issued a special price-list of the rare elements and their salts; a noticeable feature is the quotation for 16 oz. bars of metallic calcium. This metal, which for so long has been sold at a prohibitive price, is now obtained by a simple electrolytic process, and has become a comparatively cheap commercial article.

The influence of a magnetic field on luminous radiation forms the subject of the Nobel lecture which was delivered by Prof. Zeeman before the Swedish Academy of Science in 1903, and has recently been printed (Stockholm: P. A. Norstedt & Fils). It deals with the history of the discovery and the theoretical significance of the "Zeeman effect."

The fourth volume of Ostwald's "Annalen der Naturphilosophie" contains a brief sketch, by B. N. Menschutkin, of the life and work of M. W. Lomonossoff. Reference has already been made in these columns (Nature, vol. lxxii. p. 42) to Prof. Menschutkin's more complete study in the Russian language of the work of this eighteenth century philosopher; the present abstract being written in German deserves notice, as it will serve

to make more widely known the views of a man of science whose speculations were in advance of the age in which he lived.

In the *American Journal of Science* (vol. xix. p. 345) Mr. B. J. Harrington describes an investigation of a peculiar variety of fœtid calcite found near the township of Chatham, in the Grenville region of Canada. The calcite, although nearly pure, when struck or scratched evolves a powerful and unpleasant odour, which is shown to be due to hydrogen sulphide occluded in the mineral in minute cavities, probably in the liquid state. The proportion of hydrogen sulphide is about 0·016 per cent. of the weight of the calcite. A striking property of this variety is that when heated to 160° C. it shows a strong, deep yellow phosphorescence, which persists during several minutes after its removal from the source of heat.

In part i. of vol. ix. of the *Transactions of the Royal Dublin Society*, Prof. J. A. McClelland continues the investigation which has already been mentioned in these notes (vol. lxxi. p. 543) of the relation between the atomic structure of substances and their power of giving rise to a secondary radiation under the influence of the β and γ rays of radium. It is shown that as the atomic weight increases the secondary radiation also increases, and that, as regards the latter, the elements may be arranged in a series of groups which correspond strictly with the periods of Mendeléeff's classification. The curve connecting atomic weight and the power of giving rise to a secondary radiation is of particular interest, as it throws light on the manner in which atoms are built up from electrons. It is important to note that the density of a substance has comparatively little influence on its power of producing secondary radiation.

The catalogue of geological literature added to the Geological Society's library during the year ended on December 31, 1904, has just been issued. The catalogue is published by the Geological Society at the price of 2s.

The index number of the *Psychological Review* for 1904 has just been published by the Macmillan Company of New York. The index is a very complete bibliography of the literature of psychology and cognate subjects for the year 1904, and has been compiled by Prof. Howard C. Warren, of Princeton University. It occupies no less than 240 pages, and contains 3445 entries of separate papers or volumes by psychologists of all nations.

OUR ASTRONOMICAL COLUMN.

A Probable Nova in Ophiuchus.—From an examination of the Henry Draper memorial photographs in 1899, Mr. Fleming came to the conclusion that the star R.S. Ophiuchi was of the Nova type. Its spectrum, as shown on a plate taken on July 15, 1898, contained the hydrogen lines $H\zeta$, $H\epsilon$, $H\delta$, $H\gamma$, and $H\beta$, and the lines at $\lambda\lambda$ 4656 and 4691 as bright lines, thus resembling Novæ Sagittarii and Geminorum. A spectrum obtained on July 14, the preceding day, confirmed the presence of these bright lines, whereas one photographed on August 28, 1894, was simply of the K type without bright lines.

Miss Cannon recently examined the light curve of this star since 1888, and found that it varied considerably and rapidly about the time at which the bright line spectra were obtained. Thus on May 31, 1898, the magnitude was only 10·8, but a month later, on June 30, it had become 7·7, and it subsequently decreased, at the regular rate of about one magnitude per month, until on October 8 it was only 10·8 again. A minor recrudescence took place in 1900, followed by another decrease, and since then the magnitude has remained faint at about 10·0, just as other Novæ, e.g. P Cygni, have, since the waning of their initial outbursts, remained fairly constant. An examination of several good chart plates revealed only a single star in the position occupied by this body. As many previous Novæ, having spectra similar to that of this star at its brightest, have been shown to have existed in the same positions prior to their discovery, Prof. Pickering contends that R.S. Ophiuchi should be classed as a Nova, when its proper designation would become Nova Ophiuchi No. 3, the new stars of 1604 and 1848 having appeared in the same constellation (Harvard College Observatory Circular, No. 99).

Observations of Prominences on the Sun's Limb.—In No. 5, vol. xxxiv., of the *Memorie della Società degli Spettroscopisti Italiani*, Prof. Mascari gives, for 1904, his usual annual summary of the observations of solar prominences made at the Catania Observatory. From the tables given we see that the prominence activity was augmented during 1904, also that the law that as the daily frequency of prominences increases their mean heliographic latitude decreases was confirmed; in 1902 the value was 48°·4, in 1903 it was 42°·1, but in 1904 it decreased to 36°·6. During the first quarter of last year the prominences occurred with a greater frequency in the southern hemisphere, but during the other three quarters the reverse was the case, the mean daily frequencies for the year being:- northern hemisphere 1·57, southern hemisphere 1·33.

A plate issued with the preceding number of the same journal shows, graphically, the positions and magnitudes of the prominences observed on the limb during the period March 14 to May 11, 1902, at the observatories of Catania, Kalocsa, Odessa, Rome, and Zurich. By thus combining the observations made at different places, it was possible to obtain a complete daily record for the whole period, with the exception of four days. Several outstanding disturbances are obvious, especially one extending from N. 42° W. to N. 84° W., and enduring as a limb disturbance from March 14 to 18.

Determination of Meteor Radiants.—Commenting on a mathematical paper, on the determination of meteor radiants, recently read before the Royal Astronomical Society by Mr. Chapman, Mr. Denning issues a warning against the acceptance of any radiant, except in special circumstances, determined from the observations of less than five paths. The errors of observation, unless the observer has had much experience, are sufficient to overburden the catalogue of radiant points with a number of false radiants if three paths be accepted as sufficient data. When the altitude of the radiant is small, the meteors traverse long paths, and a consideration of three of these may give a satisfactory value, otherwise three is wholly insufficient. Mr. Denning advises meteor observers to keep a careful record of all faint showers suspected, and endeavour to corroborate them at the subsequent recurrences of the same epochs. By doing this and combining the results, well supported radiants may be established (*Monthly Notices of the Royal Astronomical Society*, April).

THE DEVELOPMENT OF SPECTRO-CHEMISTRY.[1]

The series of optical researches carried on by the late Dr. J. H. Gladstone, at first in collaboration with the Rev. T. Pelham Dale, established the important fact that Newton's expression for refraction, $(n^2-1)/d$, is not constant, but varies considerably with the temperature. On the other hand, it was found that the more simple ratio $(n-1)/d$ remains practically constant.

Soon after 1860, Hans Landolt came forward with his optical researches. He began by confirming the results of Gladstone and Dale. He proceeded a step further, however, by following the example of Berthelot, and comparing the refractivity, not of equal, but of molecular

[1] Abridged from a discourse delivered at the Royal Institution on Friday, May 26, by Prof. J. W. Brühl.

quantities of the substances. If P represents the molecular weight, the product $[(n-1)/d]$P is the *molecular refraction*.

Landolt examined particularly the fundamental question whether a different grouping of the same number of atoms of the same elements—which is the cause of isomerism—has any influence on the optical properties of bodies.

He established the important fact that only the relative weight of the elements is of influence on the molecular refraction of a compound, while the different grouping of the atoms has no appreciable effect; and this made it possible to determine the atomic refractions of the elements. The atomic refraction of carbon, for instance, was obtained by comparing the molecular refractions of two compounds which differed only by one atom of carbon; and in a similar manner the atomic refractions of the remaining elements were determined.

With the aid of these constants it was now possible to calculate *a priori* the molecular refraction of many organic compounds from the elements composing them, and Landolt showed that the calculated molecular refractions agreed very well with those determined by experiment.

Gladstone, in the course of his researches, was able to confirm Landolt's results in many cases. But he also found a considerable number of substances in which the observed molecular refraction was completely at variance with that obtained by adding the atomic refractions together. The exceptions were so numerous that they really seemed to overthrow the whole law of summation.

Shortly before 1880, when I was studying the literature of chemical optics, a brief note published by Gladstone in the *Journal of the Chemical Society* for May, 1870, excited my attention and curiosity. The author there discusses the exceptions to Landolt's rule of summation. He shows firstly that in all such cases the molecular refraction is never found to be too small, but always too great. Then he shows that whole classes of compounds behave in this abnormal fashion.

All optically abnormal compounds proved to be rich in carbon. Gladstone, therefore, examined the effect which a gradual increase of carbon in the composition of a body exerted on its refractivity. He found that there actually was an increase in the excess of the experimental as compared with the calculated molecular refraction, but the increase was not regular enough to explain the anomalies.

The saturated hydrocarbons, or *paraffins*, of the general composition C_nH_{2n+2}, showed *normal* molecular refraction. Also the *olefines*, containing two atoms less of hydrogen, were found normal by Gladstone. On the other hand, the hydrocarbons, containing six atoms less of hydrogen, viz. the *terpenes*, gave molecular refractions about 3 units larger than would correspond to their composition.

With the aromatic hydrocarbons, such as benzene, toluene, &c., containing eight atoms less of hydrogen, this abnormal excess amounted to 6 units:—

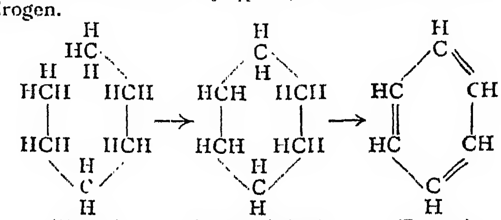
Paraffins	(C_nH_{2n+2})		Normal	
Olefines	,,	$-H_2$	,,	
Terpenes	,,	$-H_6$	,,	+3
Benzene and derivatives ...	,,	$-H_8$	,,	+6

With still further decrease in the quantity of hydrogen contained (*i.e.* with further increase of carbon), there resulted greater and greater refractive increments. The last member of the series, however—pure carbon without any hydrogen, represented by the diamond—proved to be perfectly normal in its optical properties.

It seemed to me really extraordinarily remarkable that all optically abnormal substances, without exception, gave a too *high* molecular refraction. It was no less astonishing to me that the saturated hydrocarbons were optically normal, but became more and more abnormal at successive withdrawals of hydrogen—while pure carbon, uncombined with hydrogen, is again completely normal.

But I was most particularly struck by the quantitative amount of the abnormality in the case of benzene compounds, especially their refractive increment of *six* units. The number 6 fascinated me. I could not help thinking that therein lay the key to the mystery, and I lost no time in making use of it.

According to Kekulé's ingenious hypothesis we can imagine benzene, C_6H_6, to have arisen from the saturated hydrocarbon hexane, C_6H_{14}, by successive removal of hydrogen.



(Hexane) C_6H_{14} (Hexamethylene) C_6H_{12} (Benzene) C_6H_6

Thus altogether four pairs of hydrogen atoms have been removed. The elimination of the first pair was made the occasion to form another *simple* carbon bond, like those already present in hexane, and with it the ring was closed. The splitting-off of the other three pairs of hydrogen atoms, on the other hand, resulted in the formation of three *double* bonds of carbon atoms—a kind of bond which does not occur in the optically normal hexane.

Now Gladstone had found that benzene exhibits a refractive increment of 6 units. Reading this, I was struck in a moment by the thought: might not this abnormal refractive increment of benzene be due to its double carbon bonds, which are absent in the optically normal hexane? If this were so, I went on to reason, since *three* double bonds in benzene correspond to a refractive increment of 6 units, therefore *one* double bond must entail the increment of 2.

These ideas received no support whatever from the then known facts. For Gladstone had stated expressly that the olefines, *i.e.* open-chain hydrocarbons, containing *one* double carbon bond, were optically *normal*. However, I did not allow myself to be discouraged; and my expectations were confirmed by the very first experiment. The olefine examined not only proved to be optically abnormal, but gave the predicted refractive increment of 2 units, corresponding to the presence of *one* double carbon bond. Gladstone, therefore, as I had supposed, was mistaken in this case. Further experiments proved that not one of the olefines was optically normal. Without exception they gave the refractive increment of 2 units, one-third of that of benzene.

I next proceeded to examine the di-olefines—substances which contain *two* double carbon bonds. Here also, in conformity with expectation, a constant refractive increment was found, double as large as that of the olefines and two-thirds of that of benzene:—

Paraffins	(C_nH_{2n+2})		Normal	
Olefines	,,	$-H_2$	,,	+2
Diolefines	,,	$-H_4$	,,	+4
Benzene compounds... ...	,,	$-H_8$	,,	+6

The dimensions of our subject this evening prevent the detailed demonstration of these important facts by experiment. I will only show you that the spectrum of a saturated hydrocarbon (a paraffin) is distinguishable at a glance from that of a substance containing double bonds.

On this screen we project the electric spectrum of metallic calcium. First we cause the rays of light to pass through a prism filled with paraffin oil. Then we exchange this prism for another, filled with a substance containing atoms linked by double bonds. (Experiment.)

In the second case you observe, first, a much greater deviation of the whole spectrum, *i.e.* greater *refraction*, and secondly, far wider intervals between the coloured lines of the spectrum, *i.e.* greater *dispersion*, which is usually correlative to the refraction.

Thus quantitative experimental confirmation was obtained for the view that abnormal refractive increments which increase with the diminution of hydrogen contained in the substances are caused by the presence of double carbon bonds.

At the same time, however, the experiments yielded a second result of fundamental importance. The olefines contain 2, and the diolefines 4, atoms of hydrogen less than the paraffins. Similarly the refractive increment of the olefines is 2, and of the diolefines 4.

Benzene, C_6H_6, contains 8 atoms of hydrogen less than the corresponding paraffin, hexane, C_6H_{14}. The increment of benzene, however, amounts not to 8, but to 6! Thus

in the formation of benzene from hexane, 2 atoms of hydrogen have been eliminated without influence on the refractive increment of the product.

But in the formation of benzene from hexane, 2 atoms of hydrogen have been employed to close the ring (see Fig. on p. 159). The withdrawal of these two atoms, and the closing of the ring, have therefore taken place without causing any optical anomaly.

In the formation of the olefines and diolefines from the paraffins, however, there is no closing of the ring. These substances are of open-chain structure, and *every* removal of 2 hydrogen atoms corresponds here to the creation of a double carbon bond:—

$$H_3C\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_3 \qquad CH_2=CH\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_3$$

Hexane (C_6H_{14}) Hexylene (C_6H_{12})

$$CH_2=CH\cdot CH_2\cdot CH_2\cdot CH=CH_2$$

Diallyl (C_6H_{10})

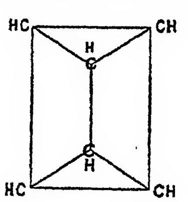
Hence, also, the refractive increment of the olefines and diolefines is directly proportional to the number of hydrogen atoms removed from the paraffin.

From all this it follows that the removal of hydrogen atoms causes optical anomalies only where double carbon bonds are created by the process. *The splitting-off of hydrogen which results in a closing of the ring is, on the other hand, without abnormal optical influence, and produces no refractive increment.*

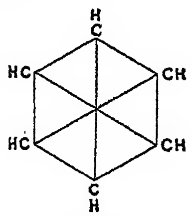
This latter principle, which has since been confirmed many times by experiment, has proved of the same importance as the first in the investigation of the chemical structure of bodies.

A few examples will show how these two principles can be utilised for the discovery of chemical structure.

Besides the formula already mentioned for benzene—that suggested by Kekulé—several others have been proposed, *e.g.* those by Ladenburg and Claus:—



Ladenburg



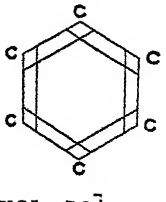
Claus

Neither of these graphic formulæ is reconcilable with the results of spectrochemical investigation, because the neighbouring carbon atoms contained in them are associated only by single, cycloid, or ring-closing affinities, and not by any so-called double bonds. Substances of this kind should be optically normal, while benzene and its derivatives are, as a matter of fact, abnormal. Kekulé's formula for benzene is really the only graphic representation of its structure in a single plane which is confirmed by chemical optics.

Thus it can be at once determined by optical methods whether a given body belongs to the paraffinoid, olefinoid, or cycloid products, whether these products contain double bonds or not, and, if so, how many.

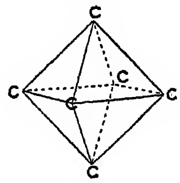
Now, too, we can imagine why the diamond, *i.e.* pure crystallised carbon, is, as already mentioned, optically normal. We obtain an idea of the chemical constitution of the mineral, and of the way in which the atoms of carbon are perhaps combined in the sparkling gem.

For the reasons already stated, the diamond cannot possibly contain any double bonds; a combination, say, in the form



with one atom of carbon at each of the six corners, and with each atom connected with its neighbour by a double bond, is altogether impossible.

Imagine, however, at each of the six corners of a regular octahedron, a single molecule of marsh-gas, CH_4, *i.e.* altogether C_6H_{24}, and then imagine all the 24 hydrogen atoms successively removed, so that each carbon atom is connected with each of its neighbours only by a single bond, and thus all six atoms of carbon are united together in a single whole. Then you obtain, as the most simple representation of the molecule of the diamond, a regular octahedron, with one atom of carbon at each of its six corners, while the edges represent the mutual bonds:—



Several simple molecules of this kind may be combined into one crystallised particle of the spectrochemically normal diamond.

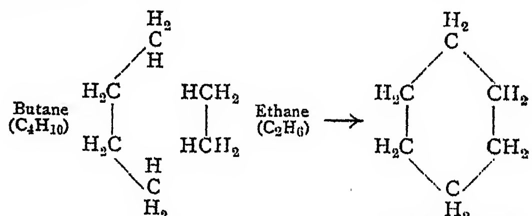
Thanks to the explanation of the optical behaviour of benzene, with the resultant discoveries, it all at once became possible to understand the causes of the spectrochemical abnormality of whole classes of bodies, such as the olefines, diolefines, terpenes, aromatic compounds, &c., and light was cast on the chemical constitution of whole classes of bodies.

At the same time, however, it at once became apparent why both Landolt and Gladstone had succeeded in observing complete optical normality in very numerous substances of the most various types—alcohols, acids, ethers, hydrocarbons, &c. And now it was understood why in such bodies the molecular refraction is determined solely by the component elements, while the different grouping of the atoms, *i.e.* the isomerism, remains without any appreciable optical influence.

All the bodies of this kind proved to be either paraffins, *i.e.* saturated hydrocarbons, or simple derivatives of the same. But the paraffins, as we now know, are always optically normal, because they contain no double carbon bonds. For this reason all such simple derivatives of the paraffins must also be normal. Their molecular refraction will thus always correspond to the elements of which they are composed, however the atoms may be grouped, *i.e.* chemical isomerism is here also without influence.

For the same reason, however, all cycloid (ring-shaped) closed formations, if they contain no double carbon bonds, must be optically normal, for those bodies also may be conceived as originating in the simple replacement of hydrogen by paraffin fragments, and may therefore be regarded as combined paraffins.

Thus we can imagine the hexamethylene already mentioned not only as formed from hexane by removal of *two* hydrogen atoms from the ends, but also as arising from ethane and butane, *i.e.* from two paraffins, by the removal of *four* hydrogen atoms and welding together of the remains:—



Hexamethylene (C_6H_{12})

As a combined paraffin, hexamethylene must be normal, as is also confirmed by experiment, and here we see again, as in the case of the diamond, that a progressive removal of hydrogen and increase of carbon need not lead to the slightest optical anomaly.

At the same time there arises here a case of the optical influence of isomerism, for hexylene, which has already been mentioned, with the same formula (C_6H_{12}) as hexamethylene, but in structure an olefine:—

$$CH_2=CH{\cdot}CH_2\,CH_2{\cdot}CH_2{\cdot}CH_3$$

possesses the familiar refractive increment of 2 units. This example again shows how the spectrochemical behaviour of a body discloses its chemical structure by enabling us to distinguish with certainty between an optically normal cycloid (or ring-substance) and an isomeric open-chain olefinoid formation, which is optically abnormal.

Carbon can thus act variously upon light according to the manner in which its atoms are combined. We can therefore transfer the refractive increment of the double bond to the atom itself.

In the diamond, and in all paraffinoid carbon compounds, the atomic refraction of carbon equals 5; it is therefore equal to 10 for two carbon atoms. The double bond increases the refraction by 2, so that for two carbon atoms with a double bond the refraction amounts to 12. The atomic refraction of *one* carbon atom with a double bond is therefore equal to 6, *i.e.* 20 per cent. greater than that of the atom with the single bond:—

	Atomic Refraction
1 Carbon atom C (diamond and paraffins)	5
2 Carbon atoms 2C (diamond and paraffins) ...	10
Double bond	2
2 Carbon atoms with a double bond (C=C ...	12
1 Carbon atom with a double bond (C=⋮ ...	6

Carbon, being a quadrivalent element, can also appear with *triple* bonds:—

$$R.C{\equiv}C.R$$

Experiment has shown that carbon with a triple bond also acquires a special atomic refraction.

Thus it becomes possible to establish the presence of this kind of bond in substances, and to distinguish it from the double and simple bonds—a further criterion of structure.

In consequence of these discoveries it became highly probable that all multivalent elements, such as carbon, possessed an atomic refraction varying with the kind of bond, while the univalent elements, such as hydrogen, display constant optic values because atoms such as theirs can only be linked with a simple bond.

Later researches have confirmed this. The univalent halogens give, like hydrogen, constant atomic refractions, both in the elementary state and in their compounds. The multivalent elements, on the other hand, such as oxygen and nitrogen, display different optical values, according to the kind of bond.

In the course of such researches the behaviour of oxygen as a quadrivalent element, which had been previously conjectured, was established with certainty, and afterwards confirmed synthetically by Collie, Tickle, and others.

The theory which accounted for the optical abnormalities of certain classes of bodies, making them, in fact, abnormalities no longer, has proved extraordinarily fruitful. It formed the starting point of all subsequent discoveries in the subject, and, indeed, we may describe the progress of this branch of science during the last twenty-five years as based essentially on this conception.

For not until we had fathomed the mystery of the benzene refractive increment 6 was it possible to know for certain that the variable valency of the multivalent elements is always of determining influence on the optical behaviour of bodies. Thus for the first time a spectrochemical method was called into being for the study of chemical structure, and the foundations were laid of what we now call "spectrochemistry."

We must now return once more to the formula for refractivity. Newton's expression $[(n^2-1)/d]P$ had proved not constant for the temperature in the case of fluid bodies, and was, therefore, replaced by Gladstone and Dale's more satisfactory ratio $[(n-1)/d]P$. For twenty years and more this did admirable service. As, however, the number of observations kept on increasing, even this formula betrayed imperfections which finally led to its abandonment. It is impossible here to follow the argument in detail, and we must be content with the remark that comparisons of bodies in different states of aggregation failed to yield satisfactory constants. The values of $[(n-1)/d]P$ for a fluid or solid substance always came out considerably greater than for the same substance in the state of gas or vapour.

Then by a happy chance two physicists, L. Lorenz, of Copenhagen, and H. A. Lorentz, of Leyden, came forward simultaneously in 1880 with a new expression for refraction. One of them started from the ordinary theory of light, the other from Maxwell's electromagnetic theory of light based on Faraday's views, and they both reached the same result, viz. that the true measure of refractivity is furnished by the expression

$$\left(\frac{n^2-1}{n^2+2}\right)\frac{P}{d}$$

Experimental tests showed that this theoretical expression was, in fact, for all bodies, practically unaffected not only by temperature and pressure, but also by the state of aggregation.

Chemical tests confirmed the utility of the new optical standard, since the operation of all the laws before mentioned was observed to be even more exact when the new constant was applied.

Moreover, the expression for refraction proved valuable in another respect. It was found to be very suitable for measuring the *dispersive* power of bodies.

If n_v and n_r denote the refractive indices for the limits of the visible spectrum, *i.e.* for violet and for red light, the difference of the refractivities for these end-rays of the spectrum,

$$\left(\frac{n_v^2-1}{n_v^2+2}-\frac{n_r^2-1}{n_r^2+2}\right)\frac{P}{d}$$

is the measure of the power of different bodies to *disperse* light—to broaden out the spectrum. This ratio proved to be constant as regards temperature, pressure, and state of aggregation.

Gladstone had already observed that dispersion, like refraction, was connected with the chemical nature of bodies. Quantitative relations were, however, only obtained when a constant for refractivity had been found. And then from the molecular dispersions of compounds the atomic dispersions of their elements were deduced.

We cannot enter here into the relations which were thus shown to exist between the chemical composition of substances and their power to disperse light. We need only remark that the case as a whole is analogous to that of refraction. Dispersion is, however, a still more sensitive and more constitutional property, and therefore in many cases it is specially adapted as an aid to research on chemical structure.

It only remains to add a few remarks on the applications of spectrochemistry in science and in practical life.

It has already been shown the principles on which spectrochemical methods of examination in general can be applied to the solution of scientific problems, to the discovery of the chemical structure of single substances or whole classes of bodies.

Now there is a large number of substances, some of them artificially built up by synthesis out of their elements, some of them occurring in the vegetable and animal kingdoms, or even in inorganic nature, the structure of which is of remarkable delicacy and instability. Among them are, for instance, the so-called "tautomeric" compounds, hydrogen peroxide, and many other unstable compounds. Substances of this kind are of a very special interest, for in consequence of their tendency to change, they are the principal cause of metamorphoses, the unceasing circulation of matter, the eternal birth and decay that go on in nature.

Research in the atomic structure of such bodies by purely chemical methods is often very difficult, and not seldom impossible, because, owing to their sensitive organisation, chemical interference leads either to changes in the grouping of the atoms, which cannot always be controlled, or even to total decomposition.

In such cases it is of course of the greatest value to be able to examine the constitution of the bodies without affecting them chemically; and spectrochemistry, as we have seen, gives us the means of doing so. By observing the behaviour of light on its passage through the various substances, we gain an insight into their structure without in any way disturbing it.

In the last ten years the spectrochemistry of the nitrogen compounds has also made remarkable progress. Nitrogen is of the greatest importance as an essential constituent of the proteids, the alkaloids, and many other animal and vegetable products. But its high valency and the extraordinary variety of combinations into which it can enter with other elements surround it with special complications. Regardless of these, however, the spectrochemical examination of nitrogen compounds has already yielded useful results, especially in the study of the alkaloids. It is to be expected that this optical method will also be of use in the chemistry of the albuminoids, the study of which is now being prosecuted with so much vigour.

One class of substances of increasing importance both to science and to chemical industry is that constituted by the natural and artificial perfumes. An overwhelming majority of them consist of derivatives of the terpenes. We have already mentioned that Gladstone, in this subject also a pioneer, was the first to study the optical behaviour of the terpenes. Since then the explanation of the structure of these bodies and of a large number of rich natural perfumes derivable therefrom has been rendered easier by the use of spectrochemical methods. Similar assistance has been rendered to the synthetic preparation of valuable scents, such as ionone, the artificial scent of violets. In every scientific laboratory and in every rationally conducted chemical factory where work is being done on perfumes, the spectrometer is now an indispensable testing instrument, and hence also an implement in industrial production.

When scientific research opens up new methods of observing nature, it is generally not long before a use is found for these methods in practical life. The need is soon felt of perfecting, and at the same time simplifying, the scientific apparatus. Efforts in this direction have not been wanting in the case of the spectrometer, and they have been crowned with the most brilliant success.

Prof. Abbe, the distinguished physicist who died not long ago, and after him Dr. Pulfrich, constructed spectrometers on the principle of total reflection. These instruments are distinguished from those formerly in use by their extraordinary simplicity and convenience, and they allow also of much more rapid work.

Such instruments, known as total reflectometers, have been made for the most exact scientific measurements, and also for medical and technical purposes. Special forms are in use for the examination of fats and oils, milk and butter; to determine the amount of salt contained in salt solutions; the amount of alcohol and extractive matter in beer; for the examination of blood and albuminoids in pathological fluids, &c. Several of these ingeniously contrived instruments give not only the refractive index and the dispersion of a substance immediately, without any calculation, but also directly the percentage of dissolved matter, *e.g.* of alcohol and extractives in beer.

THE MIOCENE FORMATION OF MARYLAND.

We have received from the Maryland Geological Survey a memoir on the Miocene formation of the State, in two volumes, text and plates. This is the second of a series of reports dealing with the systematic geology and palæontology of Maryland, that on the Eocene having been previously published, while reports on other formations are in progress. We may heartily congratulate the State geologist, Dr. Wm. Bullock Clark, on the appearance of these volumes, which in type and illustrations leave nothing to be desired, while the subject-matter, the result of labours extending over fifteen years, represents the combined work of field geologists and of experts in various branches of palæontology.

Of special interest is a chapter by Mr. W. H. Dall on the relations of the Miocene of Maryland to that of other regions and to the recent fauna. He points out that the differentiation of faunas in European and North American areas was well established before the beginning of the Tertiary, so that in the early stages of that epoch the faunas in the west show American characteristics clearly as compared with those of Europe. Other differences, suggesting migrations, occur in the relative time of appearance of certain groups; as, for instance, in America, the first influx of Nummulites is in the upper beds of the lower Oligocene, just as these lowly forms of life were about to disappear from the European fauna, where they had long flourished. In the history of the American Miocene there are many differences and many points of agreement with European equivalents, which are duly pointed out. As in Europe, the Miocene was a period of elevation, of plication of the earth's crust, of denudation, and of the deposition over extended areas of sediment, chiefly of clays, sands, and marls, more or less consolidated. Diatomaceous deposits also occur.

In an introduction Dr. Clark discusses the general stratigraphic relations of the Miocene deposits of Maryland, which have long been known for the rich faunas which they contain. The Oligocene is not represented, and the strata lie unconformably on the Eocene. The palæontological relations, the subdivisions and geographical distribution of the strata are dealt with by Mr. G. B. Shattuck, who gives an elaborate table showing the localities and horizons of the species. The bulk of the volume is taken up with the systematic palæontology, the results of an exhaustive study of the fauna, embracing both a critical review of the species described by previous authors, as well as descriptions of a large number of new forms. As remarked by Dr. Clark, the description of species of fossils is of little scientific importance to the geologist, unless the object is something more than the mere multiplication of new forms. In the present case the endeavour has been made to clear up doubtful points in synonymy and to give as complete an account as possible of the geological and geographical ranges of the fossils. All groups from the Mammalia to the Radiolaria, Foraminifera and plants come under notice. The higher vertebrates are dealt with by Dr. E. C. Case, the fishes by the late Dr. C. R. Eastman, many of the invertebrates by Dr. G. C. Martin, the Echinodermata by Dr. Clark, and the remaining groups by other authorities.

The palæontology is illustrated by 135 plates, while in the volume of text there are sections, numerous pictorial views, and a coloured geological map. The work is well indexed, and there is a useful geological bibliography.

MINERAL PRODUCTION OF INDIA.

An interesting new departure has been made by the Geological Survey of India in devoting the last issue of the *Records* (vol. xxxii., part i.) to a review of the mineral production of India during the years 1898 to 1903, by Mr. T. H. Holland, F.R.S., director of the Survey. This review, which covers 118 pages, with 6 plates, compares very favourably with the statistics of many countries where the facilities of obtaining information regarding the mineral production are far greater than in India. The period covered is six years, and it is intended in future to issue quinquennial reviews. The minerals are divided into two groups:—(1) those for which fairly trustworthy returns are available, and (2) those for which definitely recurring particulars cannot be procured. It is curious to note that in the review of mineral production in India issued by Sir George Watt in 1894, four minerals, salt, coal, iron ore, and petroleum, were the only representatives of the first group, whereas it is now possible to obtain trustworthy returns of the production of thirteen minerals, coal, gold, graphite, iron ore, jadeite, magnesite, manganese ore, mica, petroleum, rubies, salt, saltpetre, and tin.

The production of salt, which was 358,000 tons in 1898 and 336,000 tons in 1903, showed considerable fluctuations during the period under review; but in the case of all other minerals there was substantial progress. The Indian coal output rose from 4,000,000 tons in 1897 to 7,500,000 tons in 1903. The production of gold steadily increased from 390,505 ounces to 603,218 ounces. The production of saltpetre also increased, the average

annual exports having amounted to 382,000 cwt. The petroleum industry increased at a greater rate even than coal mining, the production having risen from 19,000,000 gallons in 1897 to 88,000,000 gallons in 1903. Rubies form, next to petroleum, the chief source of revenue from minerals in Burma, the value of the output having risen from 57,950*l*. to 98,575*l*. In the case of mica, India is the leading producer, and supplies half the world's consumption. The value of the mica produced in 1898 was 53,890*l*., and in 1903 86,277*l*. The waste heaps are now turned over to supply the cheaper varieties required for the manufacture of micanite for electric insulation. The rapid development of the manganese ore industry has been very remarkable. Twelve years ago mining had hardly begun, and now more high-grade ore is produced than in any other country except Russia. The value of the output in 1898 was 27,426*l*., whilst in 1903 it was 132,741*l*. Jadestone, which is being exported in increasing quantities to the Straits and China, with an average annual value of 44,770*l*. for the mineral exported, must be classed among the important minerals, its value being seven times that of the tin and half that of the rubies. Iron ore is mined to supply the Barakar works and the old charcoal furnaces still persisting in the more remote districts. In view of the fact that the imports of iron and steel are increasing year by year, there appear to be good grounds for utilising the abundant ore supplies by starting iron works on a large scale. During the period under review the graphite deposits of Travancore and the magnesite deposits of Salem received attention, and now form serious items in the comparatively limited markets of these minerals. Tin is more widely distributed in India than is generally recognised, and in South Burma river gravels are washed for tin with considerable commercial success.

The minerals for which statistics of production are incomplete are of a very varied nature, the list including alum and aluminium ore, amber, antimony, arsenic, asbestos, borax, building stones, chromite, clays, copper ore, corundum and other abrasives, gem stones, glass-making sands, lead, silver and zinc ores, millstones, mineral paints,. mineral waters, phosphates, rare earths, slate, sodium compounds, steatite, and sulphur. It is evident that there is great scope for development in the mining of metalliferous minerals and of minerals that are needed for the more complicated chemical and metallurgical industries. This is not surprising in view of the fact that by-products are indispensable sources of profit in modern chemical and metallurgical practice; and India must continue to pay taxes on imports until industries arise demanding a sufficient number of chemical products to complete an economic cycle. Until that time, ores that will not pay to work for their metal contents alone must necessarily be neglected.

DISEASES OF FOREST TREES.

THE Board of Agriculture and Fisheries has recently issued a set of nine diagrams illustrating the diseases of forest trees. The set is composed of forty-five coloured figures. Very scant attention has been paid to this important branch of forestry in the past, and it is only within comparatively recent times that such works as those of Hartig and Sommerville, Tubeuf and Smith, Marshall Ward, Massee and others have directed attention to the importance of the study of tree diseases from a practical point of view. By such means the public has come to realise that plants, like animals, are subject to various ailments which, if not attended to, may become epidemic and cause serious loss, not only in forestry, but also in the sister industries of agriculture and horticulture. As an instance of the serious loss which may be caused by fungus disease in trees, we need only mention the larch canker fungus, which has in many cases reduced one of the most stately trees of Europe to an unsightly cripple, and is thereby responsible for the loss of many hundreds of thousands of pounds in this country alone. Its ubiquity in this country is no doubt in a large measure due to the lack of proper care in the selection of localities and proper treatment of this timber tree. This is only one of the many examples of the havoc which may be wrought by epidemics among forest trees, and in addition to this the fruit-grower, the farmer, and the gardener could also furnish parallel examples to swell the list. As we have already stated, the importance of these matters is becoming greater as scientific investigation proceeds. It is of vital importance in practice that a plant disease of any kind should be recognised in its earliest stages, as it is then in most cases capable of being stamped out. It is too late to adopt preventive measures when the presence of the disease is made known by the destruction of the crop.

The importance of the whole subject to the public in general is shown by the fact that the Board of Agriculture has issued the above valuable series of diagrams, each illustration being accompanied by a printed description on a separate sheet.

The set contains the best series we have of the diseases of forest trees, and should find a place not only in all our universities and colleges, but in every school throughout the country. It is absolutely indispensable to all foresters and to those interested in the growth and production of timber.

The price, which is one shilling per diagram, should bring the set within the reach of all.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The council of the Senate has had under its consideration an offer received from the Surveyors' Institution to provide scholarships in the university, with the object of affording facilities for the higher education of surveyors in branches of scientific knowledge cognate to their profession. The council, after consultation with the Board of Agricultural Studies, is of opinion that the offer should be gratefully accepted. The scholarships will be called "The Surveyors' Institution Scholarships"; they will be three in number, one to be awarded annually. Each scholarship will be tenable for three years, and will be of the value of 80*l*. per annum.

The general board of studies has approved the name of Mr. A. N. Whitehead for the degree of Doctor in Science.

In the mathematical tripos, part i., the senior wranglers (bracketed equal) are Mr. J. E. Littlewood and Mr. J. Mercer, both of Trinity.

OXFORD.—The following have been appointed examiners in the science schools:—P. J. Kirkby (physics), D. H. Nagel (chemistry), Gustav Mann (physiology), J. G. Kerr (zoology), Robert Howden (anatomy), James Ritchie (pathology), D'Arcy Power (surgery), W. W. Fisher (preventive medicine and public health).

Decrees have been passed to authorise the expenditure of 475*l*. on extending the system of electric lighting in the university museum, to raise the total emoluments of the Wykeham professor of physics to 800*l*. a year, and to raise the salary of his demonstrator in advanced work by 100*l*. a year, so that he may take charge of the laboratory both in vacation and term time on occasions of the absence of the professor.

The honorary degree of D.Sc. has been conferred on Prof. Ray Lankester, who delivered the Romanes lecture on June 14, and the degree of D.M. on Prof. William Osler.

Only one man of science—Prof. G. H. Darwin—is included in the list of honorary degrees for the Encænia this year.

PROF. A. S. MACKENZIE, professor of physics in Bryn Mawr College, has been appointed to the chair of physics in Dalhousie College.

THE Senate of the University of Birmingham has decided to invite Sir Archibald Geikie, F.R.S., to deliver the Huxley lecture in 1906.

WE learn from *Science* that it is announced that Harvard University has received an anonymous gift of 20,000*l*. for a museum of social ethics, and 10,000*l*. from Mr. Jacob H. Schiff, of New York, for explorations in Palestine.

AN exhibition of practical work executed by students of technical classes and by candidates at the recent annual examinations of the City and Guilds of London Institute will be opened at the Imperial Institute on Wednesday, June 28, by the Right Hon. Earl Spencer.

THE announcement is made in *Engineering* that Mr. Yarrow has placed at the disposal of the council of the Institution of Civil Engineers the sum of 10,000*l.* to be applied to the education of necessitous members of the engineering profession. It is pointed out that the engineering industry of the country will benefit from this help to technical education. The old system of premium apprenticeship is passing away, and it is coming to be recognised that the prosperity of any manufacturing nation rests on engineering, and that a foundation for the commercial success of a country cannot be maintained without the aid of a body of scientific engineers. The era of happy-thought invention is fast passing, and the opportunity for original work must chiefly depend on the application of science to perfecting known principles. Gratitude should, therefore, be felt for the public spirit which has placed in the hands of the Institution of Civil Engineers the means of giving a better training to a class that has had few opportunities in the past.

THE foundation-stone of the new buildings of University College, Reading, was laid on June 6 by Lord Goschen, Chancellor of the University of Oxford. The freehold of the new buildings is a gift to the college by Mr. Alfred Palmer. The erection of the college hall and the buildings for the practical study of various branches of pure and applied science will be undertaken immediately, but substantial additions must be made to the building fund before the scheme as a whole can be carried out. At the luncheon following the ceremony, Mr. W. M. Childs, the principal of the college, said the day would be memorable in the annals of the college because of a splendid benefaction. Throughout its history the college had been exposed to peril by the absence of endowment. He then announced that Mr. George William Palmer had informed the president of the college of his intention to offer a sum of 50,000*l.* as a permanent endowment fund, to be called "The George Palmer Endowment Fund." In a letter to the president announcing his intention, Mr. Palmer said:—"My intention is to provide that the capital fund of the endowment shall not be applied to the erection of buildings, but shall be permanently invested, and that the income shall be applied to the educational work of the college. I also desire to make it a condition of my gift that the college shall maintain its *status* as a university college in the town of Reading, and that it shall always give higher teaching in literature and in science, and, further, that it shall carry on evening classes, open at moderate fees to those engaged in earning their living during the day-time." Lord Goschen, in the course of a few remarks, referred to the direct missionary work which had been conducted by the old universities through the university extension lecturers. They were, he said, the missionaries of culture throughout a great part of our islands, and they had carried the flag of culture into many a town. A great variety of subjects is now taught in the college, but all that is taught, said Lord Goschen, is taught in a thorough, academic, and scientific manner. It is for the professors to see that the cause of culture, the cause of scientific study, shall not be neglected in these days. "Amid the hustling of those who champion various causes," continued Lord Goschen, "may I at least put in a word for higher culture? May I echo what Mr. George William Palmer has written, that literature and science may hold their own in this country apart from useful knowledge?" The president of the college announced that 80,000*l.* is required for the building fund, and of that sum 35,700*l.* has been subscribed.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 11.—"On the Resemblances existing between the 'Plimmer's Bodies' of Malignant Growths, and Certain Normal Constituents of Reproductive Cells of Animals." By Prof. J. Bretland **Farmer**, F.R.S., J. E. S. **Moore**, and C. E. **Walker**.

The authors, continuing their investigations on malignant growths, have examined the so-called "Plimmer's Bodies" of cancer cells in connection with the cytological changes that occur in cancer and in reproductive cells respectively. The "Plimmer's Bodies" are found in many cancerous growths, and are most commonly encountered in the younger or growing regions of the tumour. They appear in the form of vesicles, and they consist essentially of a fairly well defined wall containing a clear space in which is suspended a small darkly staining granule (Figs. 1 and 2). They are most commonly to be met with in

FIG. 1.

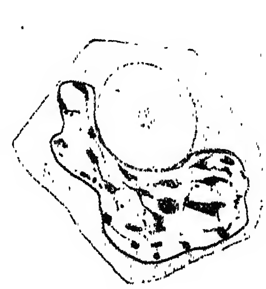


FIG. 2.

FIGS. 1 and 2.—Examples of "Plimmer's Bodies" from carcinoma. 1. Three small "Bodies" in an archoplasm. 2. Later stage in the development of the "Bodies."

tumours of a glandular or glandular-epithelial origin. They lie in the cytoplasm of the cancer cell, and usually in close proximity to the nucleus. In size, they vary from excessive minuteness to that of the nucleus itself.

The special interest attaching to them depends on the fact that they have commonly been regarded as peculiar to cancerous cells, although Honda believes he has occasionally also encountered them in inflammatory tissues. They have been variously interpreted. Some investigators have regarded them as parasitic organisms, more or less intimately connected with the etiology of the disease, whilst others have seen in them a differentiation of the cytoplasm of the cancerous cell itself. It has been suggested also that they might be derived from the centrosomes within the archoplasm, but the observations of Benda that centrosomes coexisted independently of them in the cell have rightly been held to disprove this hypothesis.

FIG. 3.—Archoplasm with centrosomes lying outside it in prophase of the first maiotic division in testis of mouse.

The authors' investigations indicate, however, that there are good grounds for re-considering the whole position, and a comparison of the processes that normally obtain during the final stages of development of the reproductive elements in man and the other mammalia appears strongly to suggest that a parallel between the "Plimmer Bodies" of cancer and certain vesicular structures occurring regularly in the gametogenic, but not in the ordinary somatic, cells, may be found to hold good.

It was shown in 1895 that during the prophase of the heterotype (first maiotic) mitosis of the spermatogenetic cells, the archoplasm undergoes a highly characteristic and peculiar metamorphosis. In normal somatic, or pre-maiotic, cells, the archoplasm is seen to lie beside the nucleus as a dusky mass of protoplasm in which are con-

tained the centrosomes. That is, the attraction sphere consists of the archoplasm *plus* the centrosomes.

But during the prophase of the heterotype mitosis these constituents become separated. The centrosomes are found to lie *outside of*, and detached from, the archoplasm (Fig. 3). At the same time the archoplasm itself undergoes a change. It becomes vesiculated, and finally, at the close of this cell generation, it is lost in the general cytoplasm of the daughter cells.

In the prophase of the second maiotic division (homotype) the same phenomena recur. When the homotype mitosis is over, the constituents of the sphere, or at least some of them, enter into direct relation with parts of the

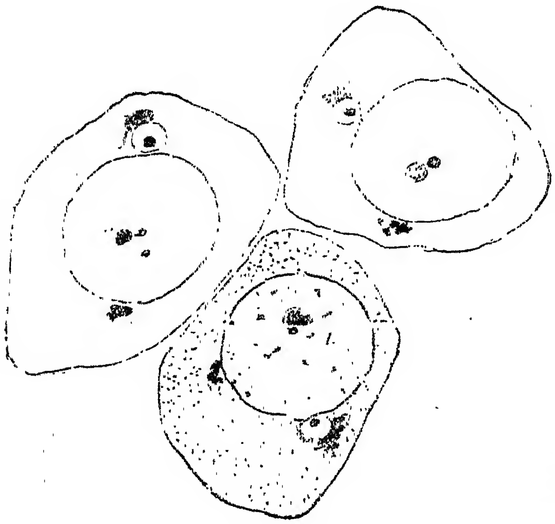


FIG. 4.

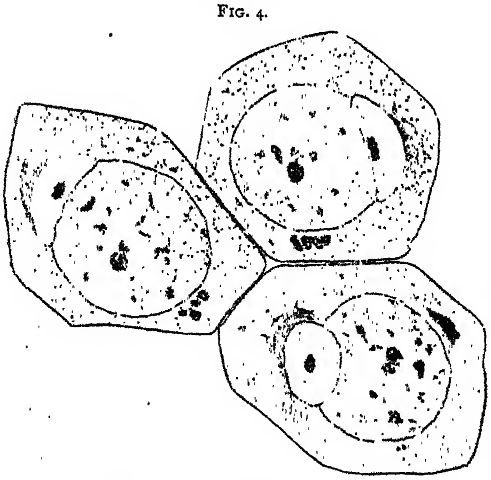


FIG. 5.

FIGS. 4 and 5.—Later stages in the development of the spermatid of mouse.

spermatozoon which arises by further differentiation of the cell. As regards the archoplasm, it is again seen to contain a number of minute vesicles which continue as before to grow in size, whilst each contains a single refractive and stainable granule (Fig. 3). Subsequently, several of these vesicles fuse together, so that at a later stage in the metamorphosis of the cell into a spermatozoon there only remains a single large clear body, bounded by a distinct membrane, containing in the centre one or more darkly staining granules (Figs. 4, 5, 6).

This body, originally described in 1895 as the archoplasmic vesicle, is a very conspicuous and apparently constant feature peculiar to the spermatogenetic cells of, at any rate, the Vertebrata, and it has since been encountered beyond the limits of that group.

When fully developed it often assumes a size approximating to that of the nucleus. Indeed, the latter is often deformed and made to assume a crescentic or cup-like shape owing to the enlargement of the adjacent archoplasmic vesicle. The vesicle and its contents ultimately form the so-called "cephalic cap" of the spermatozoon.

The remarkable similarity between the structure just described and those known as "Plimmer's Bodies" will have become obvious. It is not, perhaps, accidental that just as in the case of nuclear divisions, so also in the cellular inclusions, a parallelism between the cells of reproductive tissues and of cancer cells should be found to exist. But the cells of cancer are not therefore regarded as *identical* with those of the sexual cells, as was carefully pointed out in the first communication of the authors in 1903.

But the resemblances between what have been termed gametoid and the true gametogenic cells now seem to be even more significant than they appeared to be at that time. Both classes of cells are autonomous to a very high degree, and both possess the faculty of continuous or intermittent multiplication independently of the tissue requirements of the organism. And finally, both exhibit cellular and nuclear metamorphoses which not only, *mutatis mutandis*, resemble one another, but differ materially from those pertaining to the normal somatic cells.

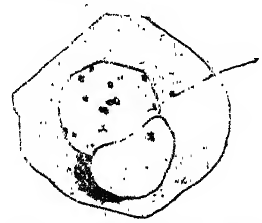


FIG. 6.—Slightly later stage in the spermatid of man, with centrosomes and tail.

It is possible that the malignant elements are the outcome of a phylogenetic reversion, but the matter is obscured by the disturbing influences that have been operative during the actual ontogeny of the cells and tissues from which these elements have sprung. If this be so, the connection apparent between gametoid and the true reproductive cells will acquire a still deeper significance; the full discussion of this question is reserved for another occasion.

May 18.—"The Atomic Weight of Chlorine: an Attempt to Determine the Equivalent of Chlorine by Direct Burning with Hydrogen." By Prof. H. B. **Dixon**, F.R.S., and E. C. **Edgar**.

In the whole of nine experiments described by the authors 9·1786 grams of hydrogen combined with 323·0403 grams of chlorine; hence the equivalent weight of chlorine, calculated in mass, is 35·195.

The number obtained for the atomic weight of chlorine is appreciably higher than that calculated by F. W. Clarke from the previous determinations, and is slightly higher than Stas's value:—

Clarke's calculation	Stas	Dixon and Edgar	
35·179 ...	35·189 ...	35·195 ...	H = 1
35·447 ...	35·457 ...	35·463 ...	O = 16

G. P. Baxter quotes the value 35·467 as being obtained by Richards and Wells for the atomic weight of chlorine —a number slightly higher than the authors'.

Chemical Society, June 1.—Prof. R. Meldola, F.R.S., president, in the chair.—The constituents of the seeds of *Hydnocarpus Wightiana* and of *Hydnocarpus anthelmintica*. Isolation of a homologue of chaulmoogric acid: F. B. **Power** and M. **Barrowcliff**. The authors found that the oils of these two seeds very closely resemble chaulmoogra oil, consisting chiefly of the glyceryl esters of chaulmoogric acid and a lower homologue of the same series, which has the formula $C_{16}H_{28}O_2$, and is designated *hydnocarpic acid*. The oil of *Hydnocarpus Wightiana* appears to contain also a very small proportion of an acid or acids belonging to the linolic or linolenic series.—The constituents of the seeds of *Gynocardia odorata*: F. B. **Power** and M. **Barrowcliff**. The oil expressed from the seeds was found to consist of the glyceryl esters of linolic acid or isomerides of the same series, palmitic acid, linolenic and *iso*linolenic acids, and oleic acid.—The relation of ammonium to the alkali metals. A study of

ammonium magnesium and ammonium zinc sulphates and selenates: A. E. H. **Tutton.** With regard to molecular volume, the topic axes, and molecular refraction, the ammonium salt of any double salt group of the series behaves almost exactly like the rubidium salt.—Camphorylazoimide: M. O. **Forster** and H. E. **Fierz.**—Influence of substitution on the formation of diazoamines and aminoazo-compounds, part iii., azo-derivatives of the symmetrically disubstituted primary *meta*diamines: G. T. **Morgan** and W. O. **Wootton.** The following new diamines have been prepared and characterised:—6-*chloro*-4-*nitro*-m-*phenylenediamine*, 6-*bromo*-4-*nitro*-m-*phenylenediamine*, and *di-iodo*-m-*phenylenediamine*.—Diazo-derivatives of monoacylated *para*diamines: G. T. **Morgan** and F. M. G. **Micklethwait.**—The significance of optical properties as connoting structure; camphor-quinone-hydrazones-oximes: a contribution to the theory of the origin of colour and to the chemistry of nitrogen: H. E. **Armstrong** and W. **Robertson.**—Solubility as a measure of the change undergone by isodynamic hydrazones. (1) Camphorquinonephenylhydrazone; (2) acetaldehyde-phenylhydrazone: W. **Robertson.**—The design of gas-regulators for thermostats: T. M. **Lowry.** Two new patterns are described. By means of one of these the temperature of a bath of water may be maintained within $\pm 0^{\circ}.01$ C. during several weeks, the average fluctuation being about $\pm 0^{\circ}.002$ C.—The constitution of barbaloin, part i.: H. A. D. **Jowett** and C. E. **Potter.** The authors have made a number of analyses and molecular weight determinations of carefully purified barbaloin and tribromobarbaloin, and their results agree best with Tilden's formula.—Influence of substitution on the formation of diazoamines and aminoazo-compounds, part iv., 5-bromo-*as*(4)-dimethyl-2-4-diaminotoluene: G. T. **Morgan** and A. **Clayton.**—The action of magnesium methyl iodide on pinenenitrosochloride: W. A. **Tilden** and J. A. **Stokes.** Two principal products are obtained, the oxime $C_{10}H_{15}(CH_3):NOH$ (m.p. 193°), and a base $C_{10}H_{16}N(CH_3)_2$ (m.p. 122°).—The action of hypobromous acid on piperazine: F. D. **Chattaway** and W. H. **Lewis.**—Racemisation phenomena during the hydrolysis of optically active menthyl and bornyl esters by alkali: A. **McKenzie** and H. B. **Thompson.**—Estimation of hydrogen peroxide in the presence of potassium persulphate: J. A. N. **Friend.** The author now shows that if a slight excess of permanganate is rapidly added from a burette to the mixture of peroxide and persulphate, and the excess of permanganate estimated iodometrically with thiosulphate, accurate results may be obtained in the presence of any weight of potassium persulphate not exceeding 0.08 gram.—Some oxidation products of the hydroxybenzoic acids and the constitution of ellagic acid: A. G. **Perkin** and M. **Nierenstein.**—The reduction of *iso*phthalic acid, part ii.: W. L. **Goodwin** and W. H. **Perkin,** jun. The authors describe a convenient method for the preparation and separation of the *cis*- and *trans*-modifications of hexahydro*iso*phthalic acid.—Complex ammonium antimonious halides: R. M. **Caven.**—The replacement of hydroxyl by bromine: W. H. **Perkin,** jun., and J. L. **Simonsen.** The authors find that good results are obtained when the acetate of the alcohol is heated at about 150° with a solution of hydrogen bromide in acetic acid (saturated at 0°).—The ethereal salts and amide of dimethoxypropionic acid derived from *d*-glyceric acid: P. F. **Frankland** and N. L. **Gebhard.**—The influence of phosphates on the fermentation of glucose by yeast juice. Preliminary communication: A. **Harden** and W. J. **Young.** It has previously been shown by the authors that the amount of glucose fermented by a given volume of yeast juice is greatly increased by the addition of boiled and filtered yeast juice. A similar initial rapid evolution of carbon dioxide occurs when a solution of sodium or potassium orthophosphate is added instead of the boiled juice, but in this case no marked prolongation of the fermentation is observed.—A contribution to the study of alkylated glucosides: J. C. **Irvine** and A. **Cameron.**

Linnean Society, June 1.—Prof. W. A. Herdman, F.R.S., president, in the chair.—Models of restorations of some extinct Dinosaurs, Ceratosaurus and Diplodocus, also of Ichthyosaurus, Plesiosaurus, Scelidosaurus, and Stegosaurus: H. E. H. **Smedley.**—Two photographs of a palm, *Corypha elata*: J. F. **Waby.** At the general meeting of June 18, 1903, photographs were shown of two specimens of equal age; one had normally flowered, fruited, and died; the other, instead of flowers, had thrown up a secondary central growth of leaves. The information now sent completes the record; the survivor in its turn had flowered and died, the inflorescences being developed from the secondary crown of foliage. On being cut down it proved to be 68 feet in height, diameter at base 3 feet 6 inches, diameter at base of secondary growth, 1 foot 10 inches. The secondary growth itself was 4 feet in height, and the height of the spadix an additional 20 feet, 5 feet of this being bare stem, the remaining 15 feet crowded with twenty-nine huge branches. The crop of fruit numbered more than 51,000 and weighed half a ton, most of the spadices being abortive.—The botany of Gough Island, part ii., the cryptogams, exclusive of the ferns and unicellular algæ: R. N. Rudmose **Brown.** The president reminded the meeting that when part i. of this paper was read on May 4 it had been suggested that a visit to the Tristan da Cunha group might form part of the programme of the Cape session of the British Association. The matter had, however, received so little outside support that the project had been abandoned.

Geological Society, June 2.—Dr. J. E. Marr, F.R.S., president, in the chair.—On the igneous rocks occurring between St. David's Head and Strumble Head (Pembrokeshire): J. V. **Elsden.** The author finds that the contemporaneous lavas of the Llanrian area agree generally in character with the eruptive rocks of apparently Ordovician age in the Strumble Head and Prescelly districts. These are all of an essentially acid type. The intrusive rocks of the area are of later date, and belong to three distinct types:—(1) the gabbros and diabases of the Strumble Head area; (2) the norites and associated rocks of St. David's Head and the surrounding district; and (3) the lime-bostonites and porphyrites of the Abercastle-Mathry district. Detailed petrographical descriptions of the different types are given, accompanied in many cases by analyses and comparisons with corresponding or related rocks of other areas.—The Rhætic and contiguous deposits of Glamorganshire: L. **Richardson.** The chief sections in the county described in detail are those at Lavernock (near Cardiff), Barry, Tregyff (near Cowbridge), Quarella (Bridgend), and Stormy Down. The Sully beds, a name given to the fossiliferous portion of the "Grey Marls" of Etheridge, are determined to belong to the Rhætic series, on account of the fossils that they contain. They are quite distinct from the "Tea-Green Marls," in which fossils have not been observed.—On the occurrence of Rhætic rocks at Berrow Hill, near Tewkesbury (Gloucestershire): L. **Richardson.** About two miles south-east from Chase-End Hill (Malvern Hills) there is a small outlier of Lower Liassic and Rhætic beds, in a basin-shaped area, supported and surrounded by Keuper Sandstone. A detailed section is given, mainly obtained by excavation, and this is compared with the nearest locality where the whole of the Rhætic may be studied, namely, at Wainlode Cliff.

Cambridge.

Philosophical Society, May 15.—Prof. Marshall Ward, president, in the chair.—Exhibition of lantern slides of fungi: Prof. Marshall **Ward.**—Infection phenomena in various species of Uredineæ: I. P. B. **Evans.**—The abortive development of the pollen in certain cross-bred sweet peas: R. P. **Gregory.** Among the offspring produced by the self-fertilisation of a certain hybrid sweet pea, Mr. Bateson obtained, during 1903, a certain number of individuals the anthers of which were contabescent. The same phenomenon was repeated in 1904, with every indication that the sterility is a character which undergoes segregation in accordance with Mendelian principles. The above paper dealt with the abnormalities observed in the nuclei of the pollen-mother-cells of the sterile plants. The vegetative mitoses are perfectly regular, the first indication of abnormality being observed in the prophase of the heterotype (reduction) division. From this point onwards the distribution of the chromatin becomes more and more irregular, with the result that no normal pollen is pro-

duced. The sterility is confined to the male organs, and the development of the embryo-sac is normal.—Crosses between fully fertile varieties of barley and varieties bearing unisexual and sexless flowers: R. H. **Biffen.**—The seed-bearing habit in the Lyginodendreæ: E. A. N. **Arber.** Although the seed (Lagenostoma) of Lyginodendron, one of the most fern-like of Upper Palæozoic plants, is known, there has, so far, been no evidence as to the manner in which the seeds were borne. A new species, *Lagenostoma Sinclairi*, has, however, been recently discovered, in which the seeds are still attached to a highly branched axis, which is of the nature of a compound frond with reduced lamina. In this respect the Lyginodendreæ agree with the other known members of the class Pteridospermeæ.—Experiments on penetrating radiation: H. L. **Cooke.** The experiments described are in continuation of a previous research by the author on penetrating radiation. By means of a small portable ionisation vessel the radiation in the Cavendish Laboratory is compared with that on the roof of the building; also when the apparatus is buried in earth, and when deeply submerged in water. A discussion of the results follows.

DUBLIN.

Royal Dublin Society, May 16.—Dr. W. E. Wilson, F.R.S., in the chair.—The influence of water-vapour upon nocturnal radiation: J. R. **Sutton.** The author shows a connection between the rate of cooling of a thermometer exposed between 8 and 10 p.m. near the surface of the ground and the relative humidity of the atmosphere, and points out that his observations will not permit of any such connection between the rate of cooling and the absolute humidity. The observations were made at Kimberley, South Africa.—On floating breakwaters: Prof. J. **Joly.** A description of breakwaters which will not rise and fall to the motion of small waves, and will not transmit them. These breakwaters are suitable for use in the shallower waters of partially protected localities.—The gases liberated on pulverising minerals—monazite: R. J. **Moss.** On reducing Norwegian monazite to powder *in vacuo* gas was obtained in the proportion of nearly 0·04 c.c. per gram of the mineral; 100 volumes of this gas contained:—hydrogen, 45·63 volumes; helium, 7·63; nitrogen, 28·93; oxygen, 7·09; carbon dioxide, 10·67. The nitrogen and oxygen being in atmospheric proportions were probably due to leakage. In addition to those gases a small quantity of water was liberated in the pulverisation of the mineral. Relatively to the helium, the quantity of hydrogen is much greater than was found in gas obtained by the same method from pitchblende.

EDINBURGH.

Royal Society, May 15.—Sir John Murray in the chair.—A new form of bolometer adapted for physiological investigation: Dr. W. **Colquhoun.** By using thin metal gratings of low resistance in a Wheatstone bridge arranged as delicately as possible, the author was able to demonstrate with it the heat produced by the beating of a frog's heart.—The magnetic quality of a Boschovichian assemblage of molecular magnets: Dr. W. **Peddie.** This paper gave a development of the theory of molecular magnetism which applies to crystals of the cubic system. The close-packed arrangement of centres was adopted, but similar treatment would apply to any other arrangement. The results were applied to the experimental data obtained by Weiss in observations on magnetite. The conclusions were:—(1) the theory is capable of giving a good account of observed phenomena; (2) in Wallerant's formula, which gives the correct mathematical relation between quantities, the quantities which he interprets as magnetisation and external force should be interpreted as internal force and magnetisation respectively. Here "internal force" means the force exerted by the group of molecular magnets. The internal action is completely represented by the quartic surface $x^4+y^4+z^4=1$.—Suggestions towards a theory of electricity based on the bubble atom: J. **Fraser.** This extension of a previous communication on the constitution of matter consists essentially of suggestions without rigid mathematical development. The treatment of conduction was of interest as suggesting a possible model of a dynamical system the properties of which simulate those of an electric conductor.—The Nudibranchiata of the Scottish National Antarctic Expedition: Sir Charles **Eliot.** The paper contained the description of two new genera and two new species.

MANCHESTER.

Literary and Philosophical Society, April 4.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—Portion of a stem of *Sigillaria vascularis* giving off a branch with the structure of *Lepidodendron selaginoides*, thus confirming Dr. Williamson's conviction of the identity of these two Coal-measure plants: Prof. F. E. **Weiss** and J. **Lomax.**—Notes on the Wilkinsons, ironmasters: F. **Nicholson.**

April 18.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—A new method of producing coloured diffusion bands: H. **Stansfield.** One surface of a piece of plate glass, rendered diffusive by spoiling the polish or coating it with a diffusing film of resin or butter, was fixed so as to be nearly in contact with the reflecting surface of a polished silver mirror, the surfaces being separated at the corners by a single thickness of stamp-edging. Greater dispersion of the colours is obtained in this way than by breathing on the glass surface of a silvered mirror, as the air film can be made much thinner than the mirror glass.—Notes on chlorine: C. H. **Burgess** and D. L. **Chapman.**

May 2.—On some constituents of Manchester soot: Prof. E. **Knecht.** The author pointed out at the outset that smoke and soot did not consist of carbon alone, as was popularly supposed, and went on to show that the soot obtained from the "fat" coal which is used in the Manchester district contains at least 50 per cent. of substances other than carbon. A variety of interesting products were shown which had been isolated from an average sample of household soot collected in Manchester. These included snow-white samples of ammonium chloride, ammonium sulphate, calcium sulphate, and a beautifully crystallised paraffin hydrocarbon which was similar in properties and composition to one which was known to exist in bees' wax. The amount of heavy hydrocarbon oils contained in our household soot was found to be no less than 13 per cent. From the brown coloured acid constituents the author had prepared a dye-stuff which was capable of producing absolutely fast shades of brown on cotton, dyed samples of which were shown. Comparative analyses of samples of soot collected in London and in Prague showed that these (especially that from Bohemian lignite) were much cleaner than the Manchester soot. After commenting on the drawbacks attendant on the presence of soot in our atmosphere, chiefly due to household fires, the lecturer expressed the opinion that no amelioration could be hoped for unless the use of more efficient fire-grates could be made compulsory.

PARIS.

Academy of Sciences, June 3.—M. Troost in the chair.—Observations on the methods employed in calorimetry, with especial reference to the determination of the heat of combustion of organic compounds: M. **Berthelot.** A polemical paper in reply to Julius Thomsen. The author strongly supports the accuracy of the results obtained by the calorimetric bomb as against the combustion under atmospheric pressure.—On the dynamics of the electron: H. **Poincaré.** A discussion of a recent paper by Lorentz on electromagnetic phenomena in a system moving with any velocity smaller than that of light.—Photographs in colour of the spectrum, negative by transmission: G. **Lippmann.** In the case of photographs on bichromatised gelatin films it has been hitherto necessary to moisten the film each time it is desired to observe the colours. By alternate treatment with solutions of potassium iodide and silver nitrate the colours become permanent and visible after drying.—The preparation and properties of the chloride and bromide of thorium: H. **Moissan** and M. **Martinsen.** The chloride of thorium was prepared by the action of well dried chlorine on metallic thorium prepared in the electric furnace. Owing to the extremely hygroscopic properties of the thorium chloride it was impossible to transfer it mechanically to a vessel for analysis, and it was therefore volatilised directly into a

glass tube in a current of dry hydrogen. The purity was determined by analysis, the melting point being found to be 720° C.—On the transmission by ticks of spirillosis and of bovine piroplasmosis: A. **Laveran** and M. **Vallée.** A specimen of the larva of *Rhipicephalus decoloratus* forwarded by M. Theiler from Pretoria, and stated by him to be the cause of the transmission of spirillosis in cattle, was allowed to act upon a healthy cow, with results entirely confirming those of M. Theiler.—The evolution of the Tertiary mammals: Charles **Depéret.**—Magnetic observations at Tananarivo: P. **Colin.** Tables are given showing the results of measurements of magnetic declination, inclination, and the horizontal component taken weekly between May, 1904, and April, 1905.—The principles of anallagmatic geometry: A. **Demoulin.**—Some new experiments on the lifting power of the helix "M. Léger" at the oceanographic museum at Monaco: M. **Léger.** The apparatus proved capable of lifting a man, together with a weight representing its motor and the petrol necessary for an experiment of one hour's duration.—A new mode of application of the Pitot-Darcy tube to the measurement of the velocity of water in pipes under pressure: H. **Bellet.** The modification suggested is the use of a two-fluid manometer, water and a liquid of density slightly greater or less than that of water; carbon bisulphide tinted with iodine gave the best results.—The magnetic properties of the simple element of pyrrhotine: Pierre **Weiss.**—On a property of the tin-aluminium, bismuth-aluminium, and magnesium-aluminium alloys: H. **Pécheux.**—The action of oxygen upon cæsium-ammonium: E. **Rengade.** The rapid oxidation of cæsium-ammonium dissolved in an excess of ammonia gives the oxides Cs_2O_2, Cs_2O_3, and Cs_2O_4, all in microscopic crystals. If the oxygen is added gradually a secondary reaction takes place, the amide and hydroxide of cæsium being formed.—Pyranic phenols: R. **Fosse** and A. **Robyn.**—On a new reagent for aconitine: E. P. **Alvarez.**—On the expansion and density of some gases at high temperatures: the application to the determination of their molecular weights: Adrien **Jacquerod** and F. Louis **Perrot.** Figures are given for air, oxygen, carbon monoxide, and carbon dioxide on the basis of the nitrogen thermometer at the melting point of gold. The molecular weights based on the density determinations at 1067° C. give for CO and CO_2 results agreeing within 1/3000th with the results of analysis; for nitrogen, the value found agrees with the atomic weight, 14·008.—Osmotic pressure in colloidal solutions: J. **Duclaux.**—On the coagulation of starch: A. **Fernbach** and J. **Wolff.**—On methæmoglobin and its fluorine combination: J. **Ville** and E. **Derrien.** The authors maintain the accuracy of their results against the criticism of Piettre and Vila.—Protagon and the cerebrines and cerebric acid preexisting in the nervous tissue: N. A. **Barbieri.** The author regards the protagon of Liebricht as a mixture of cerebrin and the cerebric acid of Fremy.—On the effects of annular decortication: Leclerc **du Sablon.**—On the results obtained by the observation of arable earths in thin plate: A. **Delage** and H. **Lagatu.** A reply to various criticisms on an earlier paper.—Researches on the ethnography of the Dravidians: Louis **Lapique.**—On the evolutions of the sexual forms in the soft-water Nereids: Ch. **Gravier.**—The simultaneous contrast of colours: A. **Polack.** The phenomenon of the simultaneous contrast of colours appears even when accidental images by the movement of the eye are completely eliminated. Under these conditions the effect of contrast depends on the state of accommodation of the eye.—On the heats of combustion and chemical composition of the nervous and muscular tissues of the guinea-pig, considered as a function of the age of the animal: J. **Tribot.**—On a new method of protection against the Röntgen rays: J. **Bergonié.** The principle of the method consists in placing the whole of the arrangements about the patient above the horizontal plane prolonging the anti-kathode, and below this plane the patient himself. The method has proved successful after six months' use.—On the denomination of the supposed agent in syphilis: Paul **Vuillemin.**—The presence of methane in the borings in Lorraine: Francis **Laur.**—Captive balloon ascents carried out over the sea by the Prince of Monaco in April: H. **Hergesell.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 15.

LINNEAN SOCIETY, at 8.—Biscayan Plankton. Part VI. Colloid Radiolaria: Dr. R. N. Wolfenden.—Biscayan Plankton. Part VII. Mollusca: Dr. P. Pelsener.—(1) Longitudinal Nerves and Transverse Veins in Bamboos; (2) Some Indian Undershrubs: Sir D. Brandis, K.C.I.E., F.R.S.—Notes on a Skeleton of the Musk-duck, *Biziura lobata*: W. P. Pycraft.—*Exhibitions: Arum maculatum*, in Relation to Insects (with lantern slides): Rev. J. Gerard, S.J.

FRIDAY, JUNE 16.

PHYSICAL SOCIETY, at 8.—On the Ratio between the Mean Spherical and Mean Horizontal Candle-power of Incandescent Lamps: Prof. J. A. Fleming, F.R.S.—The Electrical Conductivity of Flames: Dr. H. A. Wilson.—Contact with Dielectrics: R. Appleyard.—The Pendulum Accelerometer, an Instrument for the Direct Measurement and Recording of Acceleration: F. Lanchester.—A New Form of Pyknometer: N. V. Stanford.—Exhibition of a Refractometer: R. Appleyard.

MALACOLOGICAL SOCIETY, at 8.—Lecture on the Prosobranchiate Mollusca: J. E. S. Moore.—On the Extension of the Genus Macrochlamys to the Island of Mauritius: Lieut.-Col. H. H. Godwin-Austen.—Mollusca of the Porcupine Expeditions, Supplemental Notes, Part II.: E. R. Sykes.—On a Small Collection of Mollusca from Tierra del Fuego: E. A. Smith.—On two Miocene Gastropods from Roumania: R. Bullen Newton.—Revision of the New Zealand Patellidæ, with Descriptions of a New Species and Subspecies: Henry Suter.—The Conchological Writings of Captain Thomas Brown: C. Davies Sherborn.

TUESDAY, JUNE 20.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—Notes on a Recently Discovered British Camp near Wallington: N. F. Robarts.—Prehistoric Remains in West Cornwall: A. L. Lewis.

WEDNESDAY, JUNE 21.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Theories of Microscopical Vision (second paper): A. E. Conrady.—The Tubercle Bacillus: Edward M. Nelson.

GEOLOGICAL SOCIETY, at 8.—The Relations of the Eocene and the Cretaceous in the Esna-Aswan Reach of the Nile Valley: H. J. L. Beadnell.—A Contribution to the Study of the Glacial (Dwyka) Conglomerate in South Africa: E. T. Mellor.—On New Oolitic Strata in Oxfordshire: E. A. Walford.—The Causes of Variegation in Keuper Marl and other Calcareous Rocks: Dr. G. T. Moody.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—Normal Electrical Phenomena of the Atmosphere: G. C. Simpson.—Two New Meteorological Instruments; (1) Automatic Pole Star Light Recorder, and (2) The Ombroscope: S. P. Fergusson.

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THURSDAY, JUNE 22, 1905.

THE CHEMISTRY OF PLANTS.

Biochemie der Pflanzen. Vol. i. By Prof. Friedrich Czapek. Pp. xv+584. (Jena: Gustav Fischer, 1905.) Price 14 marks.

THIS work forms a new type among those on physiological botany: in some degree it resembles "Die Pflanzenstoffe" of Husemann and Hilger, and "Die rohen Stoffe des Pflanzenreiches" of Wiesner; but whereas the bias of the former is pharmacological, and that of the latter economic, the subject is treated in this volume more from the chemical standpoint.

The author states that his book is not to be regarded as a treatise or handbook for students, but as a work for reference, and that he has endeavoured to show in it what results the application of chemical methods to the problems of botanical physiology have yielded.

The subject-matter is divided into three parts—a historical introduction of 19 pages; a general part of 62 pages; and a special part of 489 pages. The general part is divided into two chapters, dealing respectively with the substratum of chemical processes in the living organism, and with the processes themselves. The first chapter treats of protoplasm and its constituents, colloids, then protoplasmic structures and their biochemical import; the second of reactions from the standpoint of general chemistry, a survey of the conditions of reactions, ionic reactions in the living cell, the velocities of reactions, catalysis, the general chemistry of enzymes, cytotoxins, and similar substances being here made.

The special part is concerned with the occurrence, metabolism, and metastasis of aliphatic substances in detail. The general arrangement of this part is in the first order chemical: the first section is devoted to fats, lecithins, phytosterins, and waxes; the second to carbohydrates, commencing with the simpler sugars, and ending with the substances forming the skeletal structure of plants. In the second order the arrangement is mixed; the chapters deal in part with the taxonomic, in part with the morphological, anatomical, and histological distribution of substances, and further with the physiology of the various bodies considered.

Photosynthesis receives considerable attention, and is regarded in all aspects; in connection with it the physics and chemistry of chlorophyll are discussed at length, and other pigments are also dealt with. The treatment of the physics and chemistry of starch is also fairly extensive. An index of the subjects and authors will be given at the end of the completed work.

The general nature and structure of the book having been reviewed, passage to criticism of it will now be convenient. A work of this kind, involving the two main ideas of chemistry and plants, requires, if it is to yield its full value, so to be arranged as to enable the composition or metabolism of a plant (in so far as this is known), as well as the distribution of a substance or a process, to be ascertained with equal ease. But this is not the case with this work owing to its arrangement; the mode of treatment is analytic rather than synthetic. In "Die Pflanzenstoffe" one volume deals with the material from the chemical, the other from the taxonomic standpoint; but this method, although very convenient, necessitates duplication. The difficulty could have been here met through use of a suitable and strictly methodical arrangement, had the divisions of various orders of magnitude been formed from different standpoints, and had those which constituted each order been of similar kind and value. The end can be still attained here by aid of a copious and well-arranged index of the subject-matter.

Printers' errors are not very numerous, and occur chiefly in the earlier part of the book.

Discrepancies and slips of the pen are noticeable here and there. For example, on p. 7 Priestley is given as the discoverer of oxygen, but on p. 12 Scheele; on p. 144 *anaërobem* should be *aërobem*; *Bedeutung* on p. 434 should be *Beleuchtung*. From the structure of a sentence on p. 39 one might suppose that ethyl-ether was insoluble in water. Further, the last paragraph on p. 313 is hardly consonant with the author's apparent acceptation of Meyer's hypothesis of the structure of starch-granules on p. 312.

Since the work is one for reference, hence a compilation, and since the author has intentionally almost entirely avoided critical remarks on the subject-matter, the reviewer can only consider the selection from a critical standpoint. It may be said, on the whole, that the selection has resulted in a very representative collection of diverse opinions on controverted questions, and in many cases almost an exhaustive one. As a result of this, condensation is, in the case of many papers, extreme, and at times there is omission; but this is almost a necessary consequence of the mass of literature consulted.

One disadvantage, which is, however, common to all books of this class, is the slight indication of the relative values of the various works cited; all emerge with equal distinctness, except in so far as more space is given to some than to others; beyond this clue there is no guide to their relative worth. This is well shown in the case of the chemistry of starch and some of the pigments; a chemist or botanist who had not devoted any special attention to these substances would rise from a perusal of the epitome here given under the impression that there was only chaos.

In connection with the chemistry of starch the author does not seem to have had at hand all the works of H. T. Brown and his collaborators, G. H. Morris and J. H. Millar, or to have grasped their views quite clearly.

Enzymes are stated to be colloidal catalysors, and their colloidal state is said to be of import. In the opinion of the reviewer there is no sufficient evidence to show that any enzyme is a colloid, and, indeed, considerable reason why many should not be so. There is even no sufficient evidence that enzymes are chemical compounds; they may be essentially mixtures, or merely functions of special conditions.

In the consideration of the action of accelerators

and retarders on amylohydrolysis, there is no mention of Ford's recent work.

Cytase is stated not to occur in resting seeds, but it is present in small amounts in some.

In giving directions for the preparation of Schweizer's solvent for cellulose, the best method, that of dissolving metallic copper in ammonia through which a current of air is passed, is not mentioned.

The function of a critic is to criticise; but he is human, and hence prone to eulogise—or blame. In this case the reviewer can only yield praise. The work fills a void that botanical physiologists have long felt. The wealth of material dealt with is surprising, and the expenditure of labour must have been enormous. There is very little evidence of partiality, whether national or of other kind. The compass of the work is wide, and it is thoroughly up to date.

The reviewer was especially pleased with the general part. For the first time in a botanical work adequate stress is put on the importance of colloids as such, and on the necessity of knowledge of their nature for progress in physiology; and for the first time the principles of general chemistry are given the position due to them in a work of this class. To Prof. Czapek for having done this all botanical physiologists must remain indebted.

In the opinion of the reviewer the value of the work would have been enhanced by incorporation in it of curves illustrating the various processes described, and by citation of mathematical expressions wherever they have been proved or found to be applicable.

If the work should run through subsequent editions, as is most likely, it would certainly be best for different authors to be delegated for various parts, since with the rapid accumulation of material it will soon be impossible for a single author to deal adequately with a work of such dimensions.

F. ESCOMBE.

THE ELECTROMAGNETIC THEORY OF INERTIA.

(1) *Mathematische Einführung in die Elektronentheorie.* By Dr. A. H. Bucherer. Pp. 148. (Leipzig and Berlin: Teubner, 1904.) Price 3.20 marks.

(2) *Experimentelle Elektrizitätslehre.* By Dr. H. Starke. Pp. xiv+422. (Leipzig and Berlin: Teubner, 1904.) Price 6 marks.

(3) *Leitfaden der Physik für die oberen Klassen der Realanstalten.* By Dr. F. Bremer. Pp. viii+294. (Leipzig and Berlin: Teubner, 1904.) Price 3.20 marks.

(1) THE property of matter which has always been regarded as most fundamental is "inertia." This property is adopted as the measure of quantity of matter in dynamics, and the nearest approach to a complete explanation of a physical phenomenon is generally supposed to have been reached when the phenomenon has been shown to be due to the motion of particles possessing inertia. We may say, in fact, that the tendency of nineteenth century physics was to give a purely dynamical explanation of everything. A striking example of this tendency is Maxwell's dynamical theory of the electromagnetic field.

In 1881 it was shown by Prof. J. J. Thomson that a particle charged with electricity possesses some inertia due to its electric charge in addition to the ordinary inertia of the particle. As the result of Kaufmann's measurements, we now know that all the inertia of an electron is of this electromagnetic kind. It is now further suggested that all matter is composed of electrons, so that all inertia is electromagnetic. Density, according to this view, is simply number of electrons per unit volume. Electromagnetic inertia, that is, all inertia, is due to the energy of the magnetic field produced by the moving charge of electricity. The energy of this magnetic field resides in the ether. According to Maxwell's dynamical theory, the electromagnetic energy of the ether is due to motion of parts of the ether, these parts possessing inertia. But the only kind of inertia which we really know is the inertia of matter, which is due to the electromagnetic action of the electrons of which matter is made up. If inertia is due to electrons, then if we ascribe to parts of the ether the property of inertia we ought to say that the ether contains so many electrons per unit volume. But the free ether is not supposed to contain any electrons; in fact, if we explain inertia by the energy of the magnetic fields produced by moving charges, then evidently to explain this energy by inertia in the ether is merely to argue in a circle. The position is, then, that inertia is explained in terms of the electromagnetic field, and that now some explanation of this field is required not involving inertia at all. So far, no such explanation has been offered. Larmor has suggested that the ether has an enormous density or inertia per unit volume, and that it moves along the lines of magnetic force. This explanation must evidently be abandoned if matter is regarded as made up of electrons having only electromagnetic energy, or else we must say that the ether has a sort of inertia, not the same as the inertia of matter, but like the kind of inertia matter was supposed to have before the electromagnetic theory of inertia was put forward.

To say this, however, is merely to ascribe to the ether a property the definition of which is that it explains what it is required to explain; it is, in fact, merely the old process of "explaining" a thing by inventing a name for its explanation. The properties of the ether, then, expressed by Maxwell's system of equations are at present without any explanation, but they have taken the place of inertia as the fundamental thing in terms of which phenomena are to be explained. In these circumstances the appearance of Dr. Bucherer's small volume on "Elektronentheorie" is exceedingly opportune. It contains a concise and readable account of Lorentz's splendid theory and of the electromagnetic theory of inertia. The introduction gives a short account of the properties of kathode rays and radium radiation, which, of course, are the properties of electrons on which the electronentheorie is based. Chapters i. and ii. contain a short account of Lorentz's theory for bodies at rest, and chapters

iii. to v. the theory for moving charges, vector analysis being used throughout. The remaining chapters deal with radio-activity, rotating charges, radiation from electrons, the Zeeman effect, the theory of Röntgen rays, aberration, and dispersion.

The mathematical theory of the properties of electrons appears to be well and clearly dealt with on the whole, and the author has managed to compress a great deal of information into a small space. English readers will probably feel that sufficient credit is not given to some English physicists to whom the initiation of the whole theory is really due. The parts of the book dealing with experimental facts and the theory of things outside the electromagnetic theory are rather superficial and sometimes erroneous. For example, it is stated that the radio-activity of radium emanation diminishes very rapidly with rising temperature, and that this can be deduced thermodynamically from the large amount of energy evolved. This glaring error shows conclusively that the author's acquaintance with the literature of radio-activity is of the slightest. The book will no doubt be welcomed by many anxious to learn about the new views on inertia and matter, and to such it should prove useful.

(2) Dr. H. Starke's book on experimental electricity and magnetism contains a very up-to-date and excellent elementary account of the subject. The explanations of many of the experiments described seem scarcely full enough to enable students actually to work from them, but it is evidently not intended that they should do so without further help. Many good diagrams of modern forms of apparatus are given.

(3) Dr. F. Bremer's book on physics for the upper classes in schools is a rather bad type of school text-book in which it is sought to make things suitable for school children by giving very short and scrappy accounts of everything. It looks like a book which might be useful to a student with a very good memory in cramming for an elementary examination in physics. He might get through the examination, but he would have learnt nothing worth knowing.

HAROLD A. WILSON.

A BOTANIST'S RECREATIONS ON THE RIVIERA.

Streifzüge an der Riviera. By Eduard Strasburger. Revised edition, with 87 coloured illustrations by Louise Reusch. Pp. xxvi+480. (Jena: Gustav Fischer, 1904.) Price 10 marks.

THE Riviera has of recent years become regarded as the playground of wealthy people whose only idea of enjoyment consists in spending hours in the unhealthy atmosphere of the casino at Monte Carlo, raising dust with a motor-car, dining at separate tables, or sitting in an hotel lounge. But such people see nothing of the *real* Riviera, with its wealth of wild flowers, its charming rock villages perched on heights, its olive, orange, and lemon groves, and its torrent beds up which one scrambles from rock to rock, passing a succession of pretty pictures each prettier than the previous one. On first reading Prof. Strasburger's book, the reviewer formed the impression that the descriptions were too prosaic and wanting in sunshine. It cannot be said that the author has succeeded in giving that warmth of colour to his account which characterises Mr. Casey's charming book. But since that impression was formed the present writer re-visited the Riviera, and the feature which he most noticed was how exactly every minute detail tallied with Prof. Strasburger's descriptions. The information contained in this book is just what is wanted to make a visit to the "Côte d'Azur" both enjoyable and instructive.

A large proportion of the text is taken up with historical accounts of the various cultivated plants and trees growing in the district. The most characteristic vegetation of the lower valleys—the vine, orange, lemon, olive, fig, cypress, and palm—is largely the result of "alien immigration." Before the hillsides were carefully terraced and cultivated they were overgrown with small scrub or "maquis" (Italian "macchia") consisting of pines, rosemary, myrtle, tree heath, three species of cistus, mastic, juniper, the characteristic spiked lavender (*Lavandula stoechas*), the remarkable spiny euphorbia (*E. spinosa*), and a number of other plants too numerous to mention. The aromatic perfume of many of these plants is one of the most salient features of the "maquis." In Prof. Strasburger's description of this characteristic undergrowth, the word "Duft" (perfume) occurs over and over again. It is only after walking through such vegetation that one realises that this very repetition makes the description all the more accurate and realistic, and readers of the book will do well to bear in mind the fact that each occurrence of the word usually refers to a different scent. Prof. Strasburger's descriptions of the "maquis" mostly refer to Antibes, where a considerable area of this primitive vegetation still remains untouched. In many places along the coast the "maquis" is being rapidly cut down to make room for unlovely vineyards, and the face of the country is being made less beautiful.

Considerable space is devoted to a description of the gardens at La Mortola, and the scent manufactories at Grasse also occupy many pages. In reading these descriptions one cannot help regarding the author somewhat in the light of a walking encyclopædia. He gives long digressions on the manufacture of chemical perfumes in connection with Grasse, and he makes his account of Sir Thomas Hanbury's garden the opportunity for giving much historical information about many economic plants such as the tea, coffee, and cocoa plants the sugar-cane—and, thence, the introduction of beet-sugar, the ebony and the camphor tree —which can hardly be regarded as the *characteristic* vegetation of the district. On the other hand, several interesting features are mentioned which a casual visitor might overlook. The characteristic flora of Hyères and the comparative absence of dust in the Esterel mountains are associated with the remarkable difference of geological formation as compared with the more frequented and fashionable but dustier winter stations in the limestone districts. The nightly concert of green frogs to which the author alludes is a sound which brings the Riviera vividly back to everyone who has heard it.

On the whole, Prof. Strasburger seems to have devoted most of his attention to studying the plants

growing in gardens and near the towns, and he does not describe many scrambles up into the distant mountains. But of the wild flowers to be found on the hillsides or up the torrent beds no better guide could be afforded than the beautiful series of coloured illustrations distributed throughout the text. It is possibly a pity that the figures are mostly printed with black outlines, and it might be thought preferable to have them printed on plates instead of mixed up with the letterpress. In addition to flowering plants, a number of the characteristic seaweeds have also been illustrated, and several charming little sketches of Riviera coast scenery, in the form of headings to the descriptions of the five different holidays spent by Prof. Strasburger on the Riviera, are a welcome addition. All these illustrations have been tastefully drawn and coloured by Fraülein Reusch.

G. H BRYAN.

INTERNATIONAL PHYSICS.

Recueil d'Expériences élementaires de Physique. By Henri Abraham. Part ii. Pp. xii+454. (Paris: Gauthier-Villars, 1904.) Price 6.25 francs.

WE have already reviewed the first part of this collection of physical experiments, which has been gathered together under the auspices of the French Physical Society. A large number of physicists from all over the world have participated in the collaboration by sending both descriptions of experiments and bibliographical references, and the editor's work has consisted in giving as much homogeneity as possible to the products of this multiple collaboration.

The present and concluding part embraces the subjects of acoustics, optics, electricity and magnetism. On the whole, the experiments in this part are of a more difficult and elaborate kind than those previously described. This is to some extent, no doubt, due to the nature of the subjects treated. General manipulation and mechanics required less reference to be made to complicated and expensive apparatus than the subjects considered here. As a consequence of this the private student who has no access to a properly equipped laboratory will find much greater difficulties in his way. He will still find a field for work in acoustics and light. With a few springs and wires a considerable amount may be done in sound; and, in the experiments on light, homely articles like pins and champagne bottles are freely made use of. But in electricity and magnetism he must be prepared for greater outlay in apparatus. We lay stress on this point, because in our previous reference we recommended the book strongly to the private student with a taste for practical mechanics.

The present part will be found of greatest utility to the schoolmaster eager for hints in the arrangement of class and lecture experiments. One special feature in the descriptions is that in most cases the dimensions of the apparatus which have been found to work well are given. This will certainly save a teacher a great deal of time, which otherwise he would need to spend in experimenting himself in order to discover the suitable size and shape of his apparatus. We do not hesitate to say, however, that time so spent is never lost, and if in the busy workaday world of the teacher some means for saving of time is essential, it has its disadvantages.

It is usually only by the somewhat laborious method of trial and error that one learns the conditions necessary for success.

There does not seem to be much in the volume which is absolutely novel as regards style of experiment. The aim, obviously, has been to describe as simple experiments as possible illustrative of all the common laws of physics. This description is in all cases very brief. There is no introduction of theoretical considerations; nor is there any attempt to make the subject attractive to a general reader. A figure, a short account of the construction and mode of using the apparatus—that is all.

In some cases the suggestions are open to criticism in minor details. Thus, vibrating springs, which ought to be attached to a fairly solid support, are shown screwed to a slender skeleton wooden box. But in the main the suggestions seem excellent, and there are few teachers who will be able to learn nothing from them.

The diagrams are not always clear; nor are they such as to give the book an attractive appearance.

Briefly, the collection is meant for the teacher and not for the student. To the former it is commended, with the hope that he will be able to give life to these somewhat dry bones by instilling his own individuality into them.

LIGHT AND HEALTH.

The Effects of Tropical Light on White Men. By Major Charles E. Woodruff. Pp. vii+358. (London and New York: Rebman, Ltd., 1905.) Price 10s. 6d. net.

THE title of this book gives little idea of the enormous field traversed by the author, or of the amazing conclusions at which he has arrived. We understand that the work is intended for laymen as well as for medical readers, and particularly for Americans about to reside in the Philippines. No exception can be taken to the advice given by Dr. Woodruff in his concluding chapters. The necessity for opaque white clothing, and of sufficient protection to the head; the paramount importance of the siesta, and of avoidance of work and social functions in the middle of the day are recognised by Europeans living in the tropics. The suggestions as to the selection of suitable recruits for the army in the Philippines are admirable.

But it is impossible to accept many of Dr. Woodruff's deductions from the scientific observations which he so largely quotes. Even if we take it for granted that the "death-rate of a place is proportional to its sunshine and inversely proportional to its latitude, other factors being eliminated," does it follow that the death-rate is dependent upon the amount of light, and have the other climatic conditions, and especially the parasitic insect life, no influence? Dr. Woodruff would have us believe so. He informs us that light is like alcohol, tea, coffee, and other stimulants. In moderation, it is beneficial; in excess, it is harmful. "We can do without it, but our metabolism is too sluggish or defective if we do not get it." Excess of

light, we are told, produces first stimulation and then depression, neurasthenia and even loss of memory. To protect us from these terrible ills we require a skin so highly pigmented that the sun's rays cannot influence our delicate nervous organisation. The want of a sufficiency of pigment in the skin, Dr. Woodruff informs us, has played an important part in the history of the world. The decline and fall of the Roman Empire and the decay of Greece were, in his opinion, due to the fact that the military forces of these powers were largely recruited from the northern blonde races. These dominating blondes, bred under cloudy skies, were reduced to impotence because their skins were insufficiently pigmented to resist the baleful influence of the bright sun of the Mediterranean. Light, and not luxury, was responsible. It is not surprising to learn that the conduct of the schoolboys of New York is worse on a bright June day than on a cloudy day in winter, but we should have thought that the author's reminiscences of his own school days would have suggested that there were other more probable causes than the irritating effect of the chemical rays of light upon the schoolboy's nervous system.

It is difficult to criticise an author who, in considering the experimental work of Ferni, whose opinion differs from his own, says, "it seems certain that he has been misquoted, and that the fact is the reverse of what he is alleged to have said." It is surely usual in a scientific treatise to verify references, but here, as elsewhere, Dr. Woodruff appears to have been rather hurried.

While admiring the author's industry and his courage in advancing his contentions, we cannot but consider many of his conclusions unwarranted. With the remark that it is a pity that our slum babies cannot undergo such "torture," we cannot forbear quoting the following statement of Dr. Woodruff:—

"We moderns of the intelligent classes alone violate the mother's instinct to hide away in the dark with her baby, and we ruthlessly thrust it out into the sun's rays, actually strapping the poor little sufferers into their carriages and torturing them with the direct rays of the sun pouring down into their faces."

OUR BOOK SHELF.

Handbuch der Heidekultur. By Dr. P. Graebner. Pp. viii+296. (Leipzig: W. Engelmann, 1904.) Price 9s. net.

THE German word "heide," like the English "heath," is applied to very different types of vegetation. In the narrowest acceptation it signifies a district covered with dwarf shrubs where ling or heather predominates, and such a formation is not uncommonly associated with loose, sandy soil. But in north Germany "heide" implies a wood, usually a pine wood, and the same conception attaches to it in other parts of Germany, as, for instance, the Dresdener Heide. Heath is therefore not a formation according to the ecological use of the word, but is applied to land where certain physical conditions prevail, and covers not only stretches of open woodland, but also grass and other moors, and may even be extended to peats and bogs. One feature common to these different formations is the presence of humus, and this is included in the definition given by Ramann.

The suggestive views as to the formation of heaths advanced by Dr. Graebner in 1901 have become widely known, and have received very general acceptance. Heaths or moors may develop on sands or under water, but in north Germany, at any rate, and not improbably in other countries, much of the heathland has taken the place of forests. Opinions differ as to the causes which have brought about the change. Borggreve and Krause have attributed the disappearance of forests to destruction by animals, but Graebner attaches more importance to continual draining of salts into the lower layers by percolating water. Another factor, which has not been sufficiently emphasised by Graebner, is the action of those bacteria which give rise to humus in the absence of air. Want of air no less than impoverishment of the soil plays its part.

Although the book is written for the practical man, Dr. Graebner has included a certain amount of purely scientific matter where it has a bearing on economic problems, but the chapter written by Mr. O. von Bentheim is more especially concerned with practical considerations. It is evident that profitable cultivation of heath land requires not only careful and scientific farming, but in some cases success can only be attained by general cooperation of the farmers either as a society or under Government supervision. The preparation of the land for agricultural farming or for tree planting is discussed in detail; as a preliminary deep ploughing is advisable and quite necessary where moor-pan has formed. Moor-pan (Ortstein) is practically a layer of stone, which is formed when percolating water containing humates reaches layers of soil which are rich in mineral salts; the humates are precipitated, and bind the particles of soil into a stratum of stone, which as it thickens cannot be penetrated even by tree roots.

In the latter portion of the book the different formations are considered from the purely botanical standpoint according to the characteristic plants. The problems connected with the cultivation of heaths are complicated but interesting; for this reason the opinions of Dr. Graebner, who has made a careful study of the subject, are the more valuable.

I Nuovi Indirizzi e le Promesse della Odierna Antropologia. By Fabio Frassetto. Pp. 71. (Castello: C. E. S. Lapi, 1905.) Price 3 lire.

THIS little work consists of a series of four lectures which the author delivered as an introduction to his course of anthropology in the 1904–5 session of the University of Bologna, where, after a break of twenty years, he has taken up the work begun by Sergi before his removal to Rome. Appropriately enough, the first lecture of the four deals with Sergi and his principles of skull classification, and sketches very briefly the types and the deductions which Sergi draws from them—Eurasian and Eurafrican forms, and five species of pygmies—at the same time pointing out that many of these views are only provisional. Dr. Frassetto holds that just criteria of race are of the utmost importance, not only for the sociologist, which most inquirers would be prepared to admit, but also for the medical man, who will more readily diagnose the maladies which he has to treat, in proportion as racial morphology and pathology are determined with precision and at the same time it becomes possible to classify the individual patient from an anthropological point of view. If he is too sanguine in this, another point on which Dr. Frassetto insists does not seem beyond the range of practical politics; this is the development of pædagogic anthropology, which shall regulate the education of the individual child by scientific principles. Even here, however, at any rate in our own case, the problem of feeding the child and of providing it with a healthy body will probably

occupy the first place for some time to come, so far as elementary education is concerned.

The second lecture deals with the work of Maggi and the morphology of the cranial bones. This is a subject on which Dr. Frassetto has himself published some valuable studies. He would have done well to indicate in his lecture that some, at any rate, of the new views on the number of centres of ossification are based on what seems to be an unduly small collection of cases. The third lecture treats of de Giovanni and his work in clinical anthropology, which deals with a patient according to his morphological characteristics rather than as an individual. Finally, we have a sketch of the work of Lombroso on criminality and genius. Dr. Frassetto insists on the need for scientific treatment of criminals, especially those of the habitual class.

It goes without saying that in brief studies of this sort we only find the broad outlines, without qualification or hint of difficulties, and herein lies perhaps a certain danger for the unfledged anthropologist who attends the academic courses. The book is, however, readable, and offers an example to English anthropologists who wish to ii terest a larger public.

N. W. T.

Catalogue of the Lepidoptera Phalaenae in the British Museum. Vol. v. Catalogue of the Noctuidæ in the Collection of the British Museum. By Sir George F. Hampson, Bart. Pp. xvi+634; pls. lxxviii-xcv. (London: Printed by Order of the Trustees, 1905.)

WE congratulate the authorities of the British Museum and the indefatigable author on the steady progress of this important work, of which a fresh volume appears, with almost clockwork regularity, every two years. The present volume is the second devoted to the Noctuidæ, and contains the second subfamily, the Hadeninæ. These are much less showy moths than those dealt with in the first three volumes of the series, and are more subdued in their colouring; but they are perhaps more interesting to British entomologists, for the family is fairly well represented in the northern hemisphere, although in a work devoted to the moths of the whole world, British, or indeed European, species are few and far between. The work is profusely illustrated, the descriptions are full but not too lengthy, and short notices of larvæ, where known (some of which are here published for the first time), have been included. The keys to the genera and the tables of species will also be found very useful by working entomologists. A table of the phylogeny of the 78 genera into which the author divides the Hadeninæ is given on p. 2, but without comment, which we think is wise, for such tables, in the present state of our knowledge, can only be tentative; and comments on the supposed affinities of genera have often a tendency to become too dogmatic.

Synonymy cannot, of course, be given in full in a work of this character, but in the case of European species, which are most burdened with it, the necessity for further details is largely obviated by a reference to Staudinger's last catalogue; still, we think that, in the case of the few British species, Barrett's "Lepidoptera of the British Islands" might have been referred to.

We heartily commend this important book to the working entomologists of all countries. Five volumes have already appeared, but if it is ever completed it will certainly far exceed in bulk the twenty-seven volumes of the "British Museum Catalogue of Birds." Hitherto it has been wholly the work of one man, and we hope that when he finally lays down his pen, a very large proportion of the gigantic task of describing the moths of the world will have been accomplished by his hands.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Spinthariscope and Retinal Excitability.

I HAVE recently been making a series of observations upon retinal excitability, and have used, among other test stimuli, the well known flashing scintillations of a pocket spinthariscope. The special value of the instrument in this connection is the subminimal or minimal intensity of the retinal excitation judged by the disappearance or appearance of visual sensation. The method used by physiologists for ascertaining whether any given condition alters the excitability of a tissue is that of stimulating periodically the tissue by subminimal or minimal exciting agencies under constant conditions and then changing one of these conditions; if, as the result of such change, the subminimal or inadequate stimulus becomes adequate, the excitability of the tissue has been raised by the change; if, on the other hand, the minimal or adequate stimulus becomes inadequate, then the excitability of the tissue has been lowered by the change.

It is well known that with the ordinary pocket spinthariscope no luminous effects are seen unless the eye has been rendered sufficiently sensitive by some minutes' darkness; this is especially the case during the daytime, the effects at night being almost instantaneously visible. The stimulation of the retina by the scintillating flashes is thus of the minimal order, and becomes subminimal when the eye is exposed to daylight.

It is thus possible to place the eye under different conditions, and to determine by means of the visibility of the flashes in the spinthariscope whether the retinal excitability has been raised or lowered; the method has the merit of great simplicity, all that is necessary being to go into a dark room and immediately look through the instrument; the time necessary for the appearance of the first visible luminosity and for the full appearance of the flashes is longer the lower the general excitability of the retina.

A further point of physiological interest is brought out by simple experiments along these lines. It is well known that when the eyes at night look at groups of stars, faint groups not in the direct line of vision are distinctly seen which disappear when the gaze is directed towards them. There is an accumulating mass of evidence that this familiar experience is the sensory aspect of a modified condition of the retina, the modification consisting in an augmented excitability of the peripheral portions of the retina. It appears probable that such peripheral augmented excitability is localised particularly in the outer segments of one set of retinal elements, the rods, which contain the visual purple discovered by Kühne. The rods are extremely numerous in the peripheral region, and constitute the sole elements in nocturnal birds such as the owl. The visual purple of the rods is blanched by light, especially by the more actinic rays, but the blanching disappears with darkness, and this re-constitution of the substance is associated with the presence of the choroidal pigment. There is thus an adaptation process which renders the dark-adapted eye more excitable than it otherwise would be, and this augmented excitability is especially prominent in that part of the retina which contains large' quantities of rods, viz. the peripheral portions. The specialised elements of the central part of the retina (macula lutea) consist in man almost entirely of cones; it is undoubted that in daylight this part is the most excitable region, and that it possesses to a remarkable degree the capacity of localised response, thus enabling two sources of light to be discriminated as distinct when so near together that they subtend an extremely small angle. At night, or with the dark-adapted eye, the whole condition is modified, and the peripheral part of the retina has its excitability augmented more than the central part, so that sources of light of subminimal intensity for the latter are adequate to excite the former; these facts are readily demonstrable by means of the spinthariscope.

Thus if in the day time the observer takes the spin-

thariscope into a dark room he will notice that the first visible effect is a slight general luminosity when the visual gaze is directed down the optical centre of the little tube. If, however, the gaze is shifted to the side of the tube, the whole spinthariscopic display with its scintillating flashes becomes distinctly visible. On opening the door of the dark room and going into the daylight the subsidence of the central and peripheral responses can be followed, whilst on returning to the dark room the re-appearance, first peripheral and then central, can be observed with great distinctness. The essential difference between the light-adapted eye and the dark-adapted eye is thus readily demonstrable, and the rapidity, as well as the efficiency, of such adaptations can be easily followed if the eye is subjected to appropriate periods of darkness and of light.

It is evident that with such a minimal test the influence of a large number of other conditions may be investigated. Without going into these, I may mention one of considerable interest. If the observing eye is kept in the dark-adapted stage by means of a removable bandage, whilst the other eye is subjected to periods of darkness followed by daylight illumination, then the visible effects in the dark room still indicate modification. In my own case illumination of one eye causes a distinct lowering of the retinal excitability of the other one, this being especially characteristic of the peripheral region of the retina. In this connection it should be remembered that the pigment cells alter in the frog as the result of illumination, and that this alteration has been shown by Engelmann and v. Gendre to occur when, the eyes being kept dark, the skin of the frog is illuminated; one eye thus influences the other. The spinthariscope with its constant minimal excitation affords a means of demonstrating this consensual effect. It appears to me that with slight modifications the instrument may become of considerable clinical value. For clinical use it has the merit of being portable and easily used. It furnishes, with no apparent decrease through time, use, &c., a constant and continually recurring stimulus which is of threshold exciting value. It can be easily applied to either the central or peripheral portions of the visual field, and gives indications which are comparable with each other, and are only altered through alterations in retinal excitability. No doubt it can be modified in form so as to be still more useful from the clinical point of view, but even in the form in which, as a scientific toy, it is now presented, its use will show whether the central or peripheral retinal excitability is abnormal, and I anticipate that before any changes can be observed with the ophthalmoscope, it will be possible by its means to ascertain alterations in retinal excitability in the early stages of disease. FRANCIS GOTCH.

Physiological Laboratory, Oxford, June 10.

Solar Changes and Weather.

IN NATURE of June 8 (p. 129) Dr. Lockyer says:—"*Up to the present time*" (italics mine) "those who have been attempting to explain variations of weather on the supposition of solar changes have been looking for the effect of solar action as either increasing or decreasing simultaneously the rainfall over the whole earth."

This is, I think, somewhat inaccurate. The possibility of a given phase of solar change being causally related to opposite weather conditions in different regions has been recognised by many, if I mistake not, for a considerable time. I might instance M. Angot, who expressly affirms it in his "Traité de Météorologie," published a few years ago; and what he there says on the subject indicates a certain currency of the idea previously, of which (no doubt increasing) currency back volumes of NATURE and other serials give evidence. The idea of a barometric see-saw in Asiatic regions, connected with sun-spots, was discussed in NATURE so far back as the 'seventies, if I remember rightly. A. B. M.

WITH regard to Mr. A. B. M.'s remarks above, may I, in the first place, mention that I am familiar with some of the meteorological researches of such high authorities as Chambers, Meldrum, Blandford, Eliot, Hann, Angot, &c., but still there seems to be a tendency for the solar changes, that is, changes indicated by sun-spots, to be considered as affecting the whole earth simultaneously at any one epoch. It would have been more correct for me to have written "Up to the present time many of those who have, &c.," than "Up to the present time those who have, &c.," but at the time of writing I was considering more the generally conceived impression as to the relation between sun-spots and meteorological changes than the results of investigation of any particular region on the earth's surface.

To take a case in point, two years ago M. Charles Nordmann (*Comptes rendus*, vol. cxxxvi., p. 1047, May 4, 1903) communicated to the Paris Academy of Sciences a paper entitled "La Périod des Taches solaires et les Variations des Températures moyennes annuelles de la Terre." This title implied that the solar changes were affecting the whole earth similarly, but the investigation was only restricted to the equatorial regions, where the conditions are most favourable for such an inquiry. Further, I am inclined to think that the result he obtained will be found to apply only to that portion of this equatorial belt lying between about longitude 40° E. and 140° E. The reason for this is that out of the thirteen stations in all which he employed, eight were included in this region (five stations of which were given double the weight of the others), and only five were situated in the other part of the belt. If it were possible to include more stations in the western hemisphere, the relation between temperature and sun-spots which he obtained might probably be reversed. WILLIAM J. S. LOCKYER.

Solar Physics Observatory, South Kensington.

Fictitious Problems in Mathematics.

ON reference to § 156 of "Rigid Dynamics," it will be seen that the definition there given is identical with that contained in Dr. Routh's letter of May 25, with the exception that the words "When the bodies . . ." occur in my edition instead of "When bodies . . . ." No statement is made as to what is meant by saying that *a body* is perfectly rough, and it is against this latter mode of expression that my attack is directed. For this reason it may be maintained that the definition given in the book in which the problem occurs is inapplicable to the problem as at present worded. Otherwise we appear to be dealing with a plank such that in the given circumstances, one of which is resting on a smooth table, the amount of friction necessary to prevent sliding can certainly be called into play, and this is apparently inconsistent with Dr. Routh's interpretation.

I would challenge your correspondent, "An Average College Don," to point to any text-book containing an explicit definition of *a* perfectly rough *body* (not *bodies*); also *a* perfectly smooth *body*. If he succeeds, I anticipate no difficulty in furnishing him with examples of questions which are either inconsistent with his definition, are ambiguously worded, or are open to some equally serious objection. G. H. BRYAN.

History of a White Rhinoceros Skull.

THE interesting specimen of the skull of the white rhinoceros (*R. simus*) referred to by Prof. H. F. Osborn, of the American Museum of Natural History, New York, in NATURE of June 8 (p. 127), was, thanks to the kindness of Mr. Graham, carefully examined by me before its sale. Its chief interest lay in the fact that the horns had never been detached, and consequently showed the true position of the nasal horn in this species; it was at right angles to the downward sloping surface of the nasal bones, thus bringing it into a most efficient position for attack.

There is a fine skull of this species in which the horns have been placed in their true position; it is numbered 2154 in the osteological series of the Museum of the Royal College of Surgeons. The animal was shot by Gordon Cumming.

The length of the nasal horn is 860 mm. (34 inches). C. STEWART.

The Romance of the Nitrogen Atom.

WITH reference to the interesting letter by Dr. Irving in NATURE of June 15 on "The Romance of the Nitrogen Atom," I should like to point out that ammonia is not so stable as is sometimes imagined. I have shown recently not only that ammonia decomposes slowly at a temperature of about 700° C., but that the decomposition is *irreversible* (*Proc. Roy. Soc.*, June), so that it will proceed until no ammonia remains. The rate of decomposition decreases rapidly with temperature, but it appears probable that even at the ordinary temperature of the air the decomposition must still proceed, although with excessive slowness. A mixture of nitrogen, hydrogen, and ammonia would thus appear to be in "false equilibrium," in the same way as a mixture of hydrogen, oxygen, and water vapour, but in the opposite sense. The "silent discharge" will decompose as well as synthesise ammonia, and brings about a state of equilibrium. Sparking has also the same effect. In these cases the equilibrium is a true one, so long as the experimental conditions remain unaltered, and it ensues when the rates of formation and decomposition of the ammonia are equal.

E. P. PERMAN.

University College, Cardiff, June 17.

Notes on the Habits of Testacella.

UNDER the above heading in NATURE, vol. xxxiv. p. 617 (October 28, 1886), Prof. E. B. Poulton recorded the capture of twenty-two specimens of this rare slug upon a wall in Oxford. On that occasion there had been exceptionally heavy rains, and it was suggested that the animals had been driven out of their usual habitat, the earth, as it became sodden with moisture. I am in a position to confirm the accuracy of this suggestion. Last evening I captured five specimens of *Testacella haliotidea* upon a stone wall near Charterhouse. The slugs were apparently crawling out of the ivy which thickly clothes the top of the wall, and were making their way back to the earth. During the previous eight days no less than 3·80 inches of rain fell at this place. It seems probable that the slugs had taken refuge in the dense shelter of the ivy while the soil was unfit for them, and that on the return of hot, dry weather were once again seeking their subterranean quarters.

OSWALD H. LATTER.

Charterhouse, Godalming, June 15.

Researches on Ovulation.

I SHOULD be greatly obliged if you would allow me to state in your Journal that the paragraph on "ovulation" in relation to œstrus on p. 517 of my text-book on the "Vertebrata," which was issued in March last, contains references to discoveries which were at that time unpublished, and that by inadvertence I omitted to direct attention to this. The information was supplied to me by Mr. Walter Heape. The facts relating to rabbits were discovered by him, those relating to ferrets and dogs by Mr. F. H. A. Marshall. These observations, with others, have recently been separately communicated to the Royal Society for publication in the Proceedings.

A. SEDGWICK.

Trinity College, Cambridge, June 16.

ABORIGINAL METHODS OF DETERMINING THE SEASONS.

AN important and timely confirmation of the astronomical significance attached to the stone circles of Britain, and to the pyramids and temples of Egypt, comes from the Far East. From an interesting paper (*Journal of the Asiatic Society*, Straits Branch, January) by Dr. Charles Hose, who has made a special study of the subject, we learn that the natives of Borneo are at the present day using just the same general principles in determining the advent of their agricultural seasons as were used by the early Britons and the ancient Egyptians between one and two thousand years B.C. It will be remembered that, in Greece, Mr. Penrose observed (see NATURE, April 6) that the Hecatompedon and the older Erechtheum, built about 1405 B.C. and 2020 B.C. respectively, were oriented to the cluster of the Pleiades at its heliacal rising on May morning. In Egypt, Sir Norman Lockyer found that the same asterism, as the deity Nit-Isis, was probably employed as the warning star for sunrise at the vernal equinox ("Dawn of Astronomy," 1894, p. 388).

Although in Great Britain there are a great number of stone circles, their astronomical significance has, until quite recently, not been satisfactorily understood. However, the recognition of Stonehenge as a solstitial temple (*Proc. Roy. Soc.*, vol. lxix. pp. 137–147) led to an inquiry into their possible character as observatories, used by priest-astronomers to determine the advent of the seed-time and other festivals, and the investigation met with gratifying results at the outset. In the case of "The Hurlers," a group of three stone circles situated near Liskeard, in Cornwall, *prima facie* evidence was found that they were arranged in their present positions, and the stones around them placed in accordance, so that the officiating priesthood could announce to the people the arrival of the crucial seasons in the agricultural year. Among the stones used as azimuth marks at "The Hurlers," there is one with an amplitude of E. 11° N., which would mark the exact heliacal rising of the Pleiades on May morning about the year 1600 B.C. (*Proc. Roy. Soc.*, March 30). In addition to the Pleiades, it has been found that the belt of Orion was frequently used as the warning sign.

Now we learn from Dr. Hose's researches that, at the present time, the natives of Borneo, more especially the Dyaks, are using the same stars in much the same way to determine the season of the year ordained by the local meteorological conditions as the time for the preparation of the ground on which they hope to grow their food supply for the ensuing twelvemonth. During the semester October to April the prevailing wind in Borneo is from the north-east, and brings rain with it; during the other six months of the year the direction of the prevalent wind is changed, but it brings none of the month-to-month variations of conditions which in lieu of more refined knowledge would lead the agriculturist of the temperate zones to a more or less approximate knowledge of the season.

In Egypt it was the advent of the Nile flood which fixed the seed-time, and for which the celestial heralds were observed; in Britain it was, as it is now, the advent of the warm, sunny weather that was the matter of importance; in Borneo it is the commencement of the driest season that has to be recognised, because the land which is to be cultivated is overgrown by jungle or forest, and, before seed may be sown thereon, a clearance must be effected. Like the Malayans, the Dyak might use the moon as his indicator, but then, like the Malayans, he would probably get about eleven days wrong every year, a serious matter where the dry season is of short duration. The variation of the length of the day is too small in the tropics to give a definite cue as to the commencement of any special season. Consequently, the Dyaks and many of the smaller neighbouring tribes have recourse to the stars, and the stars chosen as the heralds are the Pleiades ("bintang banyak") and Orion's belt ("bintang tiga"). The native names are borrowed from the Malays, and this probably indicates that the similar use of these stars is not totally unknown among the latter. The alternative expression used by the Dyaks in naming the Pleiades is "Apai andau," meaning "the father of the day," probably so called because it is the heliacal rising of them that the natives watch for before commencing their clearing process. In Borneo it is, at present, merely an observation of the Pleiades

themselves that is made; the subsequent sunrise has no urgent interest for them; but in Egypt and Britain the stars were simply the heralds of the greater luminary for which the religious sacrifice had to be prepared by the priests.

The method of making the determination is as follows:—The surrounding terrestrial phenomena suggest the approach of the dry season, and two men are then sent into the jungle—which probably means any open space with a clear horizon—to await the celestial sign. After watching for a few nights, may be a month, the Pleiades are seen on the horizon just before the light of the rising sun overcomes that of the stars. Then the messenger-astronomers return to their village and announce the fact, and the work on the forest is commenced. Should the tribe have been so misled by the workings of terrestrial nature as to delay the making of the observation until Orion's belt rises before daylight, it means that they must work "double-shift" in order to get their ground cleared in time for the vegetable matter to dry thoroughly ere the season for burning it comes round. After this recognition of the season the interest of the tribe in celestial phenomena becomes dormant until the services of the latter are again required. Not until the Pleiades reach the zenith before sunrise do they consider it advisable to set fire to the refuse, for unless the latter has had enough time to dry thoroughly it will not be completely consumed, and the ground will be of no use for rice-growing.

With the neighbouring tribes, the Kenyahs and the Kayans, the method of determining the seasons is rather more scientific, exhibiting an advanced state of knowledge. These people are acquainted with the various phenomena attending the apparent diurnal and annual movements of the sun. They know that the noon shadow is the shortest, and that it always lies in the same straight line, sometimes to the north, sometimes to the south. Consequently, they utilise this knowledge by measuring either the length of the shadow cast by a gnomon set up vertically on levelled ground, or else the length of a beam of sunlight projected through a small hole in the roof of a hut upon a plank, laid horizontally on the floor by packing it up until round discs will not roll when placed on edge on its surface. The shadow, or beam of light, is measured by means of a stick, on which there are a series of notches. The distance of each notch from the end of the stick represents the length of shadow which experience, tinged, maybe, with superstition, has taught these people to recognise as favourable, or the reverse, for the prosecution of their various agricultural operations. The stick, known as "asa do," is carefully preserved in the keeping of an older member of the tribe, duly elected to this office on account of his superior wisdom and his incapacity for more strenuous manual labour, and it is he who watches that the beam is not measured obliquely, and announces the advent of the favourable season for sowing operations to commence.

A striking phase of the question, showing how limited is the original knowledge, possibly appears in the selection of the Pleiades and Orion's belt as the "warners." Why should these two groups be selected by so many different tribes in so many widely separated ages? A plausible explanation seems to be that their forms are instantly recognisable. Whilst the aboriginal watcher would probably not be able to recognise the isolated, though bright, stars of the large constellations, especially if, as is the case with the Dyaks, no azimuth marks were employed, he could not possibly confuse either of these with any other group of stars.

WILLIAM E. ROLSTON.

THE FOURTH INTERNATIONAL ORNITHOLOGICAL CONGRESS.

THE International Ornithological Congress assembled in London on Monday, June 12, under the presidency of Dr. R. Bowdler Sharpe, and continued in session to the end of the week. The congress was instituted at Vienna in 1887 under the patronage of the Crown Prince Rudolph of Austria. The second congress was held at Buda-Pesth, and the third at Paris in 1901, so that the London congress was the fourth of the series. It was well attended by both British and foreign ornithologists—to the number of rather more than 300. They commenced their work on June 12 by an informal meeting at the Imperial Institute, South Kensington, which was the headquarters of the congress during its session.

The British ornithologists were well represented by Dr. Hartert, of Tring, and Mr. Bonhote, of Cambridge, who acted most efficiently as secretaries, while Mr. C. E. Fagan, of the British Museum, looked after the finances as treasurer. These gentlemen were assisted in their duties by Dr. Godman, Mr. Meade-Waldo, Mr. Ogilvie-Grant, Dr. Penrose, the Hon. Walter Rothschild, Dr. Sclater, and Mr. Witherby, who were all members of the organising committee. Many other well known British ornithologists attended the meetings, such as Sir Walter Buller, Dr. Butler, Mr. Dresser, Colonel Godwin-Austen, Mr. Harting, Mr. Pearson, Mr. Pycraft, Mr. Howard Saunders, and Mr. D. Seth-Smith. The French ornithologists were represented by Dr. Oustalet and Dr. Bureau, the German by Graf Hans v. Berlepsch, Dr. Blasius, and Prof. Reichenow, the Dutch by Dr. Büttikofer and Baron Snouckaert van Schauburg, the Austrian by Dr. Lorenz and Dr. Reiser, and the Italian by Dr. Giglioli and Count Arrigoni degli Oddi. From America came Mr. F. M. Chapman and Dr. Stejneger, from Switzerland Prof. Fatio and Dr. Studer, from Russia Dr. Bianchi and Baron Loudon, from Bulgaria Dr. Paul Leverkühn, from Canada Mr. Fleming, from Hungary Dr. Herman, and from Belgium Dr. A. Dubois, all names well known in ornithological science.

The first general meeting of the congress took place in the morning of June 13, when Dr. Oustalet, the last president, gave up the chair to Dr. Bowdler Sharpe, the new president, who delivered a most instructive address on the origin and progress of the great national bird-collection in the British Museum, which is under his charge. The meeting was then divided into five sections:—(1) systematic ornithology and distribution; (2) migration; (3) biology and oology; (4) economic ornithology; and (5) aviculture, which sat at stated periods throughout the week. To the first section, which was presided over by Dr. P. L. Sclater, F.R.S., about fourteen communications were made, among which were papers by Graf v. Berlepsch on new neotropical birds, by Mr. Pycraft on the importance of the study of nestling birds, which was illustrated by various pregnant instances of the secrets they have already revealed and are likely to betray in the future, and by Padre Schmitz on the birds of Madeira. In this section also, Dr. Reiser, of Serajevo, exhibited the series of North-Brazilian birds which had been obtained during Dr. Steindachner's recent expedition to the Rio St. Francisco, and Mr. Walter Rothschild showed his unique copy of "Les Voyages de Sieur B.," with the map attached, which contains much information on the now extinct birds of the Mascarene Islands.

In the second section, which met on Tuesday and Saturday, with Dr. Herman, of Buda-Pesth, in the chair, Mr. J. H. Fleming gave particulars of an unusual migratory visit of Brunnich's murre to the

interior of Canada, and Dr. Helm brought forward some new observations on the migration of the starling in Germany.

The third section, for biology, nidification and oology, was presided over by Dr. Victor Fatio, of Geneva, and received communications from the Rev. C. R. Jourdain on erythrism in eggs, and from Dr. R. Blasius on the bird-life of the Pyrenees. In this section also, Mr. Frank M. Chapman, of New York, delighted his audience by his vivid description of the breeding-places of the scarlet flamingo and brown pelican in the Bahamas, which he had lately visited, and by his excellent photographic illustrations of these birds and their nests.

Mr. H. E. Dresser took the presidential chair in the fourth section, which was devoted to economic ornithology and the protection of birds, and was well attended. Papers were read here by Dr. Herman on his recent observations on the constituents of the food of birds, by Sir John Cockburn on the legislation that had taken place in Australia for the preservation of bird-life, and by Mr. T. Digby-Pigott on the present state of the laws on the same subject in Great Britain and Ireland, which seem to require careful revision. Mr. Frank E. Lemon, secretary of the Royal Society for the Protection of Birds, also lectured on the same subject.

In section five (aviculture) the communications were not so numerous, but Mr. D. Seth-Smith, the editor of the *Avicultural Journal*, did not omit to urge the importance of his special branch of ornithology as an aid to scientific study, which, indeed, is now generally admitted.

Besides the sections, general meetings were held on the Wednesday and Friday, at which various ornithological topics of general interest were discussed. Papers were read by Dr. Paul Leverkühn, of Sophia, on the breeding-places of the vultures and eagles in the Balkans, by Dr. Herman on the state of ornithology in Hungary and on the theory of the migration of birds and its origin, and by Mr. J. L. Bonhote on the hybridisation of ducks; while Mr. W. S. Bruce gave an interesting account of the ornithological results of the Scottish Antarctic Expedition which are now being worked out. Besides these papers, Dr. Edward Wilson gave an excellent lecture on the birds obtained and observed in the Antarctic seas and lands during the recent National Antarctic Expedition, and showed off the manners and customs of the penguins in a long series of photographs.

Thursday, June 15, was entirely devoted to a visit to the great zoological museum at Tring, of which the birds (under the curatorship of Dr. Hartert) form one of the most prominent features. It is needless to say that the ornithologists were most hospitably received and entertained by Mr. Walter Rothschild, who further delighted the visitors by a lecture on birds extinct or likely soon to become so, one of his pet subjects of study. This lecture was illustrated by the exhibition of a splendid series of specimens of the birds in question, for which the Tring Museum is celebrated, and by numerous drawings collected from every quarter whence information on this subject could be obtained.

At the final meeting, held on Saturday, June 17, it was agreed that the next assemblage of the International Ornithological Congress should take place in 1910 in Germany, with Dr. Reichenow, of Berlin, as president, and Dr. R. Blasius and Graf Hans von Berlepsch as vice-presidents. It was hoped that the meeting would be held at Berlin, but the president and vice-presidents were authorised to select any other city in Germany as the place of assemblage in case they should find it more expedient to do so. It was also agreed, on the motion of Mr. Walter Rothschild, to send telegrams to the Governments of Tasmania and New Zealand requesting them to interfere with the destruction of the penguins in the Antarctic islands now carried on in order to obtain the small quantity of oil which is contained in the bodies of these unfortunate birds.

THE THAMES FLOW AND BRITISH PRESSURE AND RAINFALL CHANGES.

DURING the years 1903 and 1904 there appeared two reports dealing with the flow of the Thames in relation to the rainfall of the river's basin, the first being published by the London County Council and the second by the Thames Conservators. The material dealt with extended over the period 1883 to 1903, and the very close association between rainfall and flow was clearly brought out.

In a recent communication to the Royal Society by Sir Norman Lockyer and the writer, an attempt has been made to discuss data from the year 1860 up to the present time, involving not only statistics of rain-

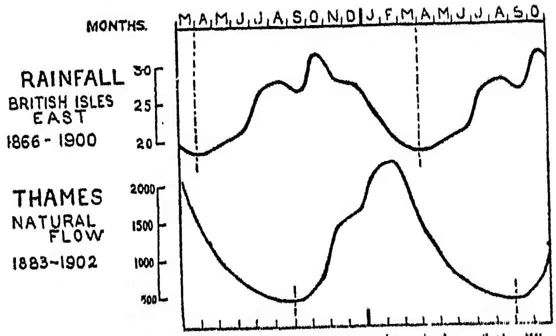

FIG. 1.—The curve representing the mean annual variation of the Thames flow lags five months behind that of the mean annual rainfall of the British Isles.

fall over a wider area than that dealt with in the above mentioned inquiries, but changes of barometric pressure in Great Britain and certain distant areas.

In consequence of the fact that the British annual variation of rainfall is at a minimum in about April and a maximum in about October, the rainfall observations have been grouped into twelve months extending from April to the following March, both months inclusive. The annual variation of the river flow (see Fig. 1) for similar reasons necessitated a different grouping of the twelve months; in this case the year was taken to cover the period September to the following August, both months inclusive. The flow of the river will thus be seen to lag five months behind the rainfall.

In the following curves here reproduced the rainfall for each group of twelve months (April to March) is compared directly with the river flow for the twelve months commencing in September of the same year.

Re-computing the rainfall and river statistics, published in the above mentioned reports, according to these new divisions of the year, the changes from year to year can be seen in Fig. 2 (curves iii. and iv. continuous lines). To investigate variation in the river flow previous to 1883, an application to the Thames Conservators resulted in securing original data which have enabled the curve to be traced back to the year 1860 (Fig. 2, curve iii., dotted portion). As a check on the whole of this curve another series of gauge readings was similarly treated, and these are shown in curve ii. The synchronous variations in

the two curves thus indicate that either curve may be taken to represent the flow changes.

In the above mentioned reports the curve representing the rainfall of the river basin from 1883 (curve iv.) was deduced from the statistics of twelve stations covering a comparatively small area. It happens, however, that these rainfall variations in this valley are not restricted to this region alone, but are similar to those which occur over a very large area in the British Isles. By employing the Meteorological Office records, and computing them according to the present adopted system of grouping of months, curves can be obtained which commence in the year 1866. Investigation has shown that this type of variation is nearly common to England S., Midland Counties, and even the combination of Scotland E., England N.E. and E., and the Midlands, as can be gathered from the curves in Fig. 2 (curves v., vi., vii.).

The other districts in the British Isles (with the exception of Scotland N., which is different from all other districts in these isles) are of a type similar to each other, but present variations which, although not widely different from the eastern and other districts, are sufficiently unlike them to be classified apart.

The rainfall of the British Isles is produced mainly by the passage of areas of low pressure travelling over the country in a north-easterly or easterly direction. It should therefore be expected that on the average the greater the rainfall the more numerous the cyclones, and consequently the lower the mean value of pressure. In the United Kingdom, therefore, the rainfall variations from year to year should correspond very closely with the *inverted* pressure changes. That this is so can be seen by comparing the *inverted* Oxford pressure curve in Fig. 2 (curve viii.) with the rainfall curves underneath. Instead of Oxford, any other town in the United Kingdom, such as Armagh, might have been taken (curve ix.), for the pressure changes are so remarkably similar over a very wide area.

It will thus be seen that the pressure, rainfall, and river flow are all intimately related, and any method of forecasting pressure would make it possible to determine beforehand the rainfall. Since the Thames flow has a lag of five months on both rainfall and pressure, a means is possibly available of stating the "expectancy" of excessive or deficient amount of water in the river.

It may here be pointed out that it does not seem necessary to collect and discuss the data over the whole of this region before any deduction *for practical purposes* can be made regarding the flow of the Thames. The barometric and rainfall observations made at the Radcliffe Observatory, Oxford, exhibit variations from 1860 up to the present time so very similar to those of the Thames flow that all three curves are very nearly interchangeable.

So striking is the agreement that they are here reproduced (Fig. 3).

The question now arises, can British pressure be forecasted?

It has been previously pointed out in this Journal (vol. lxx. p. 177, June, 1904) that there exists a world-wide barometric see-saw between two nearly antipodal parts of the earth, the one region about India and its neighbourhood behaving in an *inverse* way to that of South America and the southern parts of the United States. In some regions, and the British Isles was one of them, the pressure variation curves were found to be a distinct mixture of both the Indian and South American types, and it was difficult to classify them.

To illustrate this, the accompanying figure is given

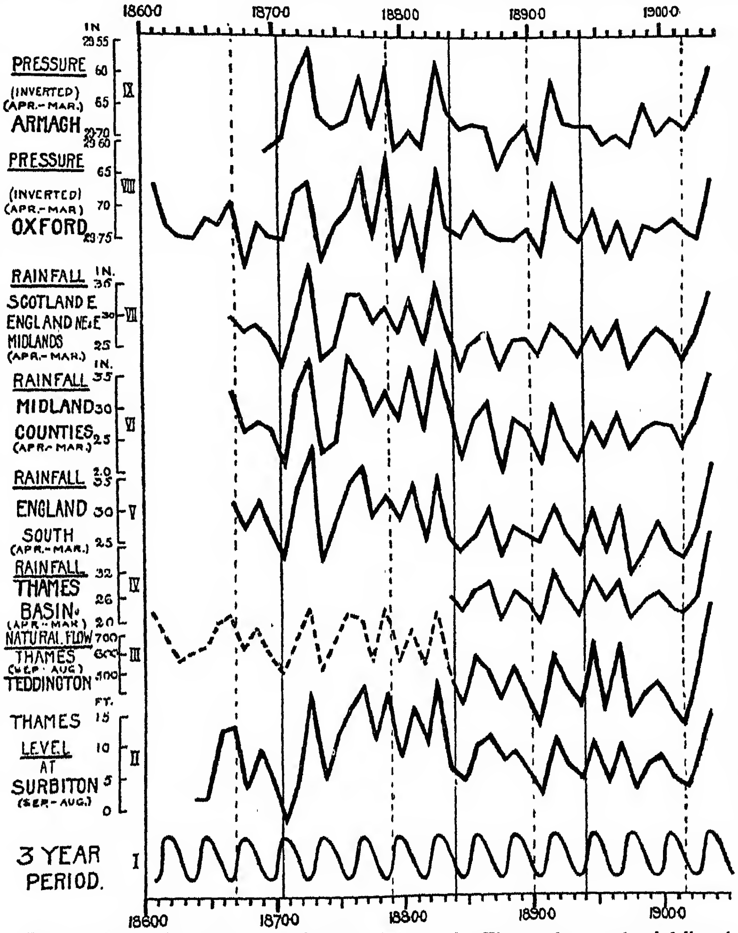

FIG. 2.—Curves illustrating the similarity between the Thames flow, and rainfall and pressure (curves inverted) in the British Isles. [The continuous and dotted vertical lines represent the epochs of sun-spot maxima and minima respectively.]

(Fig. 4). The upper curve represents an hypothetical curve with a period of 3·8 years, and beneath it the South American (Cordoba) pressure curve. At the very bottom is given the *inverse* of this hypothetical curve, and above this the Indian (Bombay) curve. Between the Bombay and the Cordoba curves is given that of Oxford. It will be noted that the Cordoba curve disagrees with its hypothetical curve in the years 1892 and 1900 to 1903, while the Bombay curve shows anomalies in 1892 and 1901 to 1903.

If, now, the Oxford pressure be compared with those of Cordoba and India, and a list made showing the years in which high pressure at Oxford coincides with years of high pressure at Cordoba or India, or low pressure at Oxford with low pressure at Cordoba

or India, the following table is the result (omitting average conditions):—

Agreement between Oxford and		Years of simultaneous excess: High pressure		Low pressure
Cordoba	...	1874	...	—
,,	...	1875	..	—
,,	...	—	...	1877
India	...	—	...	1878
,,	...	1880	...	—
,,	...	—	...	1882
,,	...	1884	...	—
,,	...	—	...	1886
Cordoba	...	1893	...	—
,,	...	—	...	1895
India	...	1896	...	—
,,	...	1899	...	—

It will be seen that there is a very even balancing between Cordoba and India. A most interesting point is that the Oxford curve seems to favour for series of years the two main pressure types alternately. From 1900 the type of variation seems somewhat indefinite.

This table seems to suggest that during some years the British area is enveloped in the pressure system that extends over the large region in which India is about the centre, while for another series it is dominated by the antipodal pressure system of which South America is the middle portion.

It is possible that it is this alternate reversion from one type to the other that prevents the 3·8-year change of the Indian and Cordoba curves from occurring in the British curves, and substitutes for it an apparent shorter period of about three years, which is very noticeable for some series of years in the British curves (Fig. 2, curve i.).

It will thus be seen that it is difficult at present to forecast British pressure correctly, but further research will very probably render it possible when more is known about the mechanism of the atmosphere.

In conclusion, it is interesting to note that in addition to this short period variation the curves (Fig. 2) indicate one of longer duration. An examination of these statistics, when the curves are smoothed by taking three-year means to eliminate the short period changes, shows that when the river flow was greatest, *i.e.* between about the years 1873–1883, the rainfall was highest and the pressure lowest, which is exactly what was to be expected from the relationship between pressure, rainfall, and river flow in these islands. Another point here indicated is that this long period change is real, and that there is a tendency now for the low river levels, deficiency of rainfall, and excess pressure of the last decade or more to be replaced by a greater mean flow of the river, increase in the rainfall, and a diminution in the barometric pressure.

WILLIAM J. S. LOCKYER.

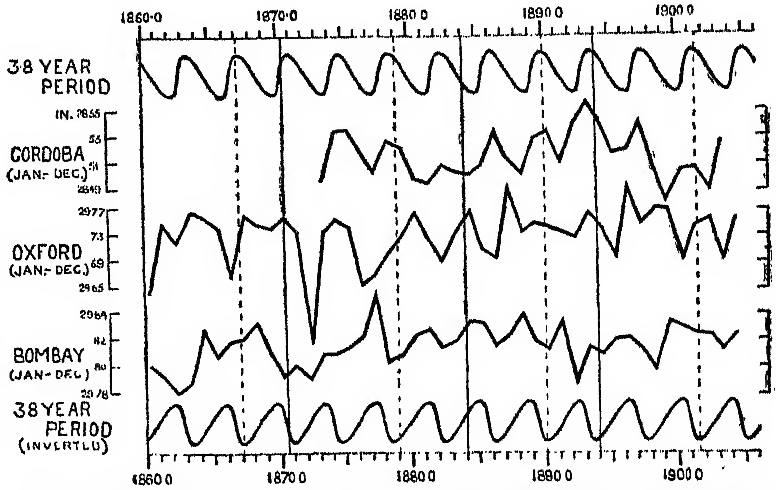

FIG. 4.—Curve to illustrate the relation between the British (Oxford) pressure change and those of India (Bombay) and S. America (Cordoba).

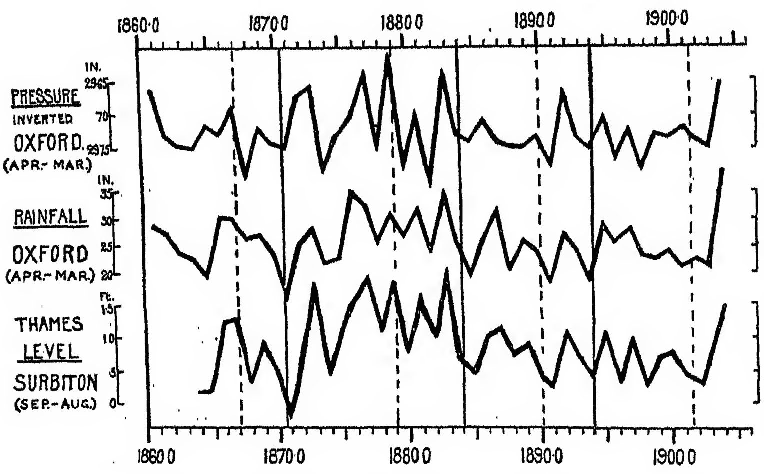

FIG. 3.—Curves to show the similarity between the flow of the Thames and the rainfall and pressure (inverted) changes at one station, namely, Oxford.

NOTES.

A ROYAL garden party was held on Wednesday, June 14, and was attended by about six thousand guests. At the end of the official record of notable people present, supplied to the *Times* by the "Court Newsman," we read:—"Invitations were issued to their Excellencies the Foreign Ambassadors and Ministers, with the *personnel* of their Embassies and Legations, the members of the Government, the Households of the King and Queen and of the Royal Family, and to many peers, members of Parliament, naval and military officers, clergy, and representatives of the musical, dramatic, and literary professions, many of whom with their wives and daughters were present at the party." We believe His Majesty the King is interested in the scientific as in the other activities of his subjects; but if so, it is clear that he is very badly served by the Lord Chamberlain's office, which is responsible for the issue of the invitations. Apparently, this department of the State has not yet realised that science is the only true basis of a nation's welfare and progress, and that scientific men exist in Britain. A few of the most distinguished Fellows of the Royal Society would represent the best interests of the nation even more effectively than actors and musicians.

THE Royal Society's annual conversazione, to which ladies are invited, will take place on Friday, June 23.

PROF. E. RAY LANKESTER, F.R.S., has been elected president of the British Association for the meeting to be held at York next year.

THE Stephen Ralli memorial—a laboratory for clinical and pathological research—will be opened at the Sussex County Hospital, Brighton, on Thursday next, June 29.

AT the Borough Polytechnic Institute on Wednesday next, June 28, marble busts of Joseph Lancaster and Michael Faraday (the work of Mr. H. C. Fehr), presented to the institute by Mr. Passmore Edwards, will be formally unveiled by Prof. S. P. Thompson, F.R.S. Mr. Edric Bayley, chairman of the governors, will preside.

THE annual conversazione of the Royal Geographical Society will be held at the Natural History Museum, South Kensington, on Tuesday next, June 27.

AT the meeting of the Royal Geographical Society to be held in the evening of June 26, a paper will be read by Dr. Charcot on the French Antarctic Expedition. Dr. Charcot has just been created a Chevalier of the Legion of Honour.

WE learn from the *Times* that the Government of India has ordered the introduction of a standard time, with effect from July 1, on the railways (other than small local lines, where the change might be inconvenient) and in all telegraph offices in the country, and also in Burma. Hitherto Madras time has been adopted by most of the Indian railways. The standard now to be introduced is nine minutes in advance of the "railway time," as it is called in all parts of India, and is thus 5½ hours in advance of Greenwich, being the local time of longitude 82° 30′. The standard for Burma is to be exactly an hour earlier, viz. 6½ hours in advance of Greenwich and five minutes earlier than Rangoon local time. In inland places it has been found convenient generally to follow railway time; but the great seaports of Calcutta, Bombay, and Karachi have followed the local time of their respective longitudes. The Government of India does not prescribe the new standard for these and other places following local time, but if a general desire to adopt the new standard is evinced, the Government will be prepared to support the change and to cooperate in bringing it about. In all probability, therefore, there will, ere long, be a uniform time throughout India exactly 5½ hours in advance of Greenwich, while that of Burma will be 6½ hours in advance.

THE death of Mr. James Mansergh, F.R.S., on June 15, at seventy-one years of age, deprives applied science of an acknowledged authority upon water supply and sewage disposal. Mr. Mansergh had unique experience and knowledge of these subjects, and was associated for many years with almost every important construction connected with them in this country. The extensive schemes which he initiated and directed for the improvement of water supply and drainage will long remain as monuments to his memory. He was the designer of the waterworks and sewerage of Lancaster (where he was born in April, 1834), Lincoln, Stockton, Middlesbrough, Rotherham, Southport, Burton-on-Trent, Melbourne (Australia), Birmingham, and many other large towns. These designs include some of the largest schemes of water supply and drainage ever carried out, such, for instance, as the sewerage scheme for the metropolitan district of Melbourne, embracing an area of 133 square miles, and the supply of water to Birmingham from a source in Radnorshire seventy-three miles away. This scheme utilises water from the rivers Elan and Claerwen, and natural reservoirs have been formed for the water by constructing immense dams below the point where the two rivers meet. Mr. Mansergh was the author of about 150 reports upon schemes of water supply, sewerage, and sewage disposal for many large towns. He was also the author of "Lectures on Water Supply: Prospecting for Water, Prospecting and Boring," delivered at the School of Military Engineering, Chatham, "The Water Supply of Towns," and other works. While president of the Institution of Civil Engineers in 1900-1, the Engineering Standards Committee was formed, and Mr. Mansergh was elected chairman. At the time of his death, as chairman of the main committee, he had more than thirty committees working on standardisation in different branches of engineering. Mr. Mansergh was a member of the Royal Commission on Metropolitan Water Supply, and he was on the council of the Institution of Mechanical Engineers. He was elected a Fellow of the Royal Society in 1901 for his eminent work as a hydraulic engineer.

IN the *Irish Naturalist* for June Dr. R. F. Scharff records the capture of two female bottle-nosed dolphins in Dublin Bay in April last. The only other record of the occurrence of *Tursiops tursio* in Irish waters dates from 1829. Dr. Scharff figures one of the Dublin specimens.

WE have received a copy of the March issue of the Bulletin of the Cracow Academy, to which Mr. V. Kulczyński contributes the continuation of an article on certain spiders, treating in this instance of *Araneus cucurbitinus* and its allies. In other articles Mr. T. Browicz discusses the secreting function of the nucleus in the cells of the liver, while Mr. K. Wójcik describes the infra-Oligocene strata of Riszkania, near Uzsok, with lists of the fossils.

A NOTICEABLE feature in the report of the Zoological Society of Philadelphia for the past year is the attention paid to the causes of the deaths which take place in the menagerie. In 140 instances a pathological examination was instituted, mostly with definite results in determining the cause of decease. The results are tabulated, and show that tuberculosis is by far the most fatal ailment, next to which comes inflammation of the stomach and intestines, followed, with a considerable diminution in the numbers, by nephritis, necrosis of the liver, and non-tubercular pneumonia.

IN the April issue of the *Emu* the editors continue the excellent practice of giving coloured illustrations of some of the more remarkable Australian birds, the plate, which is drawn by Mr. H. Grönvold, depicting in this instance representatives of Xerophila, Mirafra, and Amytis. In the case of *Xerophila castaneiventris,* one cannot help wondering what is the purpose of the pair of yellow eye-like spots at the root of the beak. Among the articles is an interesting account, with photographs, by Mr. A. J. Campbell, one of the editors, of that remarkable bird the kagu of New Caledonia, in the course of which attention is directed to the danger of extermination now threatening that species. Thirty years ago it had already disappeared from the more settled parts of Caledonia, and the writer urges that steps should be taken, while there is yet time, to preserve such an interesting bird (the sole representative of its genus) from extermination.

THE problems of "vitalismus" are discussed by Mr. K. C. Schneider, of Vienna, in *Biologisches Centralblatt* of June 1 at considerable length; while in another article Dr. H. Schmidt, of Jena, enters on the consideration of the fundamental law of biological development. In a

third communication Dr. R. Rössle insists on the importance of immunity-reactions (that is to say, serum reactions and blood-immunity) in determining the systematic affinities of the higher animals, pointing out that by this method the intimate affinities respectively existing between fowls and pigeons, horse and ass, fox and dog, and sheep and goats, have already been established. The translation of an article by Prof. Marcus Hartog, published in the *Proceedings of the Royal Society,* constitutes the next most important part of the contents of this issue.

THE most important articles in *Indian Public Health* for May (vol. i., No. 10) deal with the milk question in India and the Calcutta milk supply.

SOME interesting observations on the influence of the root nodules upon the composition of soy beans and cowpeas have been made by Messrs. C. D. Smith and F. W. Robison (Bulletin No. 224 Michigan State Agricultural College Experiment Station). The conclusion is arrived at, after two years' work, that while on fairly fertile soils the root nodules may not notably increase the yield, they do cause an important and pronounced increase in the relative and absolute amount of nitrogen in the plants.

BULLETIN No. 23, by Dr. Herzog, of the Bureau of Government Laboratories, Manila, is devoted to a consideration of plague, and a description of the pathological findings in twenty cases which occurred in Manila. A new species of rat flea (*Pulex philippensis*) is described. Bulletin No. 24, by Dr. Wherry, gives a report of two cases of human glanders which occurred in Manila, and some notes on the bacteriology and morphology of the *Bacillus mallei.*

IN the *Bull. Internat. de l'Acad. des Sciences de Cracovie* (No. 1, January) M. Panek contributes a chemical and bacteriological study of the Polish "barszcz," a product of the fermentation of red beetroot. It is brought about by a micro-organism, named by the author *Bacterium betae viscosum,* which causes a fermentation of the cane-sugar with the production of viscous substances and mannite. M. Tochtermann describes the action of thionyl chloride on thiobenzamide, M. Niemczycki discusses syntheses effected by means of zinc chloride, and Madame Krahelska the merogonic development of the egg of *Echinus microtuberculatus.*

THERE has been a considerable amount of uncertainty with regard to the blackwood of southern India, whether it was possible to distinguish two species. Mr. T. E. Bourdillon, writing in the *Indian Forester* (March), is able to show that *Dalbergia sissoides* and *Dalbergia latifolia* should be regarded as distinct species. The natives recognise dark blackwood, species latifolia, and pale blackwood, species sissoides, and although there are several points of distinction, the wood forms the best means of identification.

To the Cowthorpe oak which grows near Wetherby, in Yorkshire, and was illustrated in NATURE of May 11 (p. 44), is generally assigned the honour of being the largest tree in the British Isles. The claim is based upon the girth and spread of the tree, as it is doubtful whether it ever attained a great height. The *Yorkshire Herald,* May 29, provides an illustration, reproduced from a painting, which is believed to be an accurate representation of the tree as it appeared sixty years ago, and extracts are given from a pamphlet issued with the picture. There is no doubt that this oak passed through its seedling stage several centuries ago; Dr. Jessop, in 1829, suggested an age exceeding 1500 years, but this is mere conjecture, as the tree has been hollow for at least two centuries.

THE eighteenth and latest volume of the *Transactions of the Royal Scottish Arboricultural Society* contains the accounts of the society's meetings during 1904, the jubilee year. The president, Mr. W. S. Fotheringam, in reviewing the progress of the society, announced that the list of members had reached a thousand. The yearly excursion which was held in France provided an opportunity of visiting some of the magnificent State forests. At Champenoux and Haye the forests are principally oak, but beech and hornbeam are also grown, since they provide useful cover. Previously the system adopted was coppice-with-standards, but in both cases this is being converted into high forest. A very fine forest of silver-fir worked with a rotation of 144 years was inspected at Celles, in the Vosges.

PROF. E. WIEDEMANN, of Erlangen, sends us a short statement of observations described in his work on electric discharges (*Wied. Ann.*, xx., p. 793, 1883) relating to the effects referred to by the Rev. F. J. Jervis-Smith in our correspondence columns on May 4 (p. 7). He agrees with Mr. Jervis-Smith as to the action of ozone, and advises persons who work for a long while with influence machines not to have these machines situated in the working room. "Ozone belongs to the poisonous gases and is the more dangerous, since the injurious effects are not manifest at the time; on the contrary, breathing the gas produces at first a feeling of exhilaration, but afterwards it has a depressing effect on the nervous system. Binz has shown that it may cause sleep. I may add to what I have mentioned that during my observations I have suffered somewhat severely from nervous disturbance (hyperasthesia of the feet) due to breathing ozone. These lasted for one or two years. Moreover, I always experience discomfort after performing experiments in my lectures on Tesla discharges."

SINCE March, 1904, several meteorological stations have been established by the Japanese Government along the coast of Korea. In April of that year the Japanese meteorological observatory in Chemulpo commenced to record observations. Mr. H. Mukasa, writing from Chemulpo, informs us that a new building for the observatory was completed lately on the top of the highest hill in Chemulpo (lat. 37° 29′ N., long. 126° 37′ E.), seventy metres above mean sea-level, where observations have been taken since January 1 last. At the invitation of Dr. Y. Wada, the director, the important residents of Seoul and Chemulpo visited the observatory on March 25 last. Various pieces of apparatus relating to meteorology, as well as the horizontal seismograph devised by Prof. F. Omori, were exhibited. Among the visitors were the Japanese, French, and British Ministers, and several Korean dignitaries. The exhibition succeeded in arousing the interest of the visitors in meteorology, and made a deep impression on the Korean guests.

WE have received a copy of the first report of the Transvaal Meteorological Department, containing observations for one year ending June 30, 1904, with an appendix giving monthly and seasonal rainfall records for a number of years, from observations taken before the establishment of the meteorological department. This was only constituted in April, 1904, consequently the records are very incomplete, so far as official stations are concerned. In some cases a complete year's observations are pub-

lished, thanks to the courtesy of volunteer observers. The department has, however, lost no time in obtaining properly verified instruments, but the difficulties may be gathered from the fact that out of two consignments of grass minimum thermometers only one instrument survived the transport. The heights of the stations are not yet accurately known; many of them have an altitude of 5000 feet to 6000 feet.

THE thirteenth yearly report of the Sonnblick Society for the year 1904 contains an interesting account of some of the results obtained at the highest mountain meteorological stations of Europe, with photographic illustrations; the arduous work done in the interest of meteorological and physical science at some of these inhospitable localities has from time to time been referred to in our columns. In the present report A. Edler von Obermayr discusses the frequency of sunshine at the summit of the Sonnblick (3106 metres) with that at other mountain stations. The tables exhibit some peculiarities:—on Ben Nevis the greatest frequency occurs in June, on the Obir and Säntis in July and August, but on the Sonnblick the greatest frequency occurs exclusively in the winter months, from November to February. A useful index is given in a separate paper of the various items and unusual occurrences contained in the Sonnblick reports for the twelve years 1892–1903.

IN his earliest researches on the properties of gaseous fluorine, M. Henri Moissan showed that it reacted vigorously with nitric acid, fluorine and the vapour of the acid producing a violent explosion. In the current number of the *Comptes rendus* MM. Moissan and Lebeau give an account of a systematic research on the reactions between fluorine and the compounds of nitrogen and oxygen. Nitrogen peroxide and nitrous oxide proved to be perfectly indifferent towards fluorine, but a lively reaction, accompanied by flame, was found to take place between fluorine and nitric oxide. With the nitric oxide in excess, the gaseous products proved to be nitrogen, nitric oxide, and nitrogen peroxide, the fluorine appearing in the form of a solid product of indefinite composition containing platinum (from the tube by which the gas was led in) and nitrous compounds. But with the fluorine in excess, the reaction appeared to be more definite, and a gaseous compound containing fluorine, nitrogen, and oxygen was produced, the substance being solid at the temperature of boiling oxygen. This solid, when allowed to boil off, could be condensed to a colourless liquid at −80° C., and further work is being carried out with the view of establishing its composition and properties.

A SHORT report has been received upon the present state of the work done in connection with the "Technolexicon" of the Society of German Engineers. In the compilation of this universal technical dictionary for translation purposes (in German, French, and English), which was commenced in 1901, about 2000 firms and individual collaborators are assisting at present. Up to now 2,700,000 word-cards have been collected; and this number does not include hundreds of thousands of cards that will result from the working out of the original contributions not yet taken in hand. The editor-in-chief of the "Technolexicon" is Dr. Hubert Jansen, Berlin (NW. 7), Dorotheenstrasse 49, and he will be glad to give any information concerning the work.

A KEY to the first part of "A New Trigonometry for Schools," by Mr. W. G. Borchardt and the Rev. A. D. Perrott, has been published by Messrs. Geo. Bell and Sons.

OUR ASTRONOMICAL COLUMN.

STARS WITH PECULIAR SPECTRA.—Mrs. Fleming has discovered several more new variable stars and other objects having peculiar spectra whilst examining the Henry Draper memorial plates. The designation, position for 1900, magnitude and spectral peculiarities are given for each of these in No. 98 of the Harvard College Observatory Circulars. Several of the objects mentioned have bright lines in their spectra, and one or two call for special remark. For example, a star in Cepheus at R.A. = 0h. 7·6m., dec. = +71° 32′, was found to have a spectrum containing five bright bands at λλ 3869, 4101, 4340, 4688, and 4861. The first of these coincides with the bright band seen in certain gaseous nebulæ, the second, third, and fifth will be recognised as due to hydrogen, whilst the fourth, the brightest of all, corresponds to the characteristic line seen in fifth-type stars. The chief nebula line at λ 5000 was not seen. Prof. Pickering suggests that this object may have arrived at an intermediate stage between a nebula and a fifth-type star.

Another star situated in the position R.A. = 1h. 50·2m., dec. = +62° 49′, in the constellation Cassiopeia, is now classed as a gaseous nebula, its spectrum consisting of the chief nebula line at λ 5000.

A second table in the same Circular describes the spectra of twenty-one known variables, and Prof. Pickering states that in most cases of long-period variables the bright hydrogen lines are not seen during the epochs of minima.

VARIABLE STARS IN THE CLUSTERS MESSIER 3 AND 5.—The hundredth Harvard College Circular contains a discussion by Prof. Bailey of the variable stars discovered in the clusters Messier 3 and Messier 5. These two clusters contain a greater proportion of variable stars than any other hitherto examined. Of every seven stars in the former one is a variable, whilst in Messier 5 the ratio is 1 : 11. Periods have been determined for most of the variable stars, and their similarity is remarkable. Only two stars, Nos. 42 and 50 in Messier 5, having periods of 25·74d. and 105·6d. respectively, appear to depart from the rule, all the other variables in both clusters having periods differing but little from 13h. The average deviation from the mean (13h.) in Messier 3 is 1h. 0m., and in Messier 5 (mean 12h. 45m.) 1h. 13m. All the variables are of nearly the same magnitude, varying from 13·0m. to 16·0m., and there is a slight suggestion that the periods of them undergo a secular variation in length.

SPECTROHELIOGRAPH RESULTS.—In No. 4, vol. xxi., of the *Astrophysical Journal*, Mr. Phillip Fox, of the Yerkes Observatory, discusses the observations made with the Rumford spectroheliograph during 1904. The plates secured with the H_2 radiation, *i.e.* the radiation of the centre of the H calcium line, show a decided increase of activity in the flocculi over that observed during 1903, and are being measured in order to determine the solar rotation period at the height, above the photosphere, of the high-level flocculi.

Many series of plates, on which the individual exposures were made at intervals of a few minutes, the successive settings of the secondary slit being made in ten or twelve steps from λ 3952·4 to λ 3968·6, were secured, and Mr. Fox briefly discusses these in regard to the distinction between faculæ and flocculi in the calcium vapour images. Such a series of photographs, taken on August 25, is reproduced on one of the plates accompanying the paper, and shows that few, if any, flocculi appear in the high levels without their bases appearing, although usually diminished, in the lower levels. Even the bright patches designated "eruptions" by Messrs. Hale and Ellerman can be traced as such as far down as the photograph taken with the secondary slit set at λ 3967. The photographs secured with the hydrogen radiations $H\beta$, $H\gamma$, and $H\epsilon$ generally show flocculi coincident with those seen on the calcium photographs, and in nearly all cases where the eruptions could be traced to the limb associated prominences were discovered above the flocculus.

No prominences of great height or unusual form were photographed on the limb during 1904, but some of the plates show a fair number, and one or two beautiful examples are reproduced on the second plate of the paper.

VISIBILITY OF D_3 AS A DARK LINE IN THE SOLAR SPECTRUM.—At a recent meeting of the Royal Astronomical Society, Prof. A. Fowler stated, in a paper on the spectrum of the great sun-spot of February last, that he had, on February 2, observed the helium line D_3 as a dark and distorted line in the spectrum of the sun in the region about the spot disturbance. This observation was regarded as unusual, but according to a letter written by Mr. A. Buss to the *Observatory* (No. 358) it is not at all an uncommon phenomenon, and can be seen frequently if the solar spectrum be closely watched. In fact, Mr. Buss states that, according to his observations with a curved slit spectroscope, D_3 may be seen as a dark line in every really agitated solar disturbance.

WEST HENDON HOUSE OBSERVATORY.—No. 3 of the Publications of the West Hendon House Observatory (Sunderland) is devoted to the observations of variable stars made by Mr. Backhouse during the years 1866–1904. The observations of each of the forty-nine stars discussed are set out in detail in tables showing the times of observation, the comparison stars, and the magnitudes according to other catalogues. For a number of stars the observed magnitudes are plotted on a series of curves placed at the end of the volume, with a diagram showing the various gradations of colour employed in the descriptions.

NATURE AND MAN.

THE annual Romanes lecture was delivered by Prof. E. Ray Lankester, F.R.S., in the Sheldonian Theatre, Oxford, on June 14, on the subject of "Nature and Man." The complete lecture has been published by the Clarendon Press (London: Henry Frowde), and the following abstract indicates a few of the points considered in it.

Prof. Lankester remarked that the subject of his discourse is one which has largely occupied the attention of biologists during the five-and-forty years in which he has followed the results of scientific discovery. Much misconception prevails as to the signification attached to the word "Nature," but the lecturer used it as indicating the entire cosmos of which this cooling globe with all upon it is a portion. Until the eighteenth century the study of nature—nature-knowledge and nature-control—was the appropriate occupation of the learned men at Oxford, and the present peculiar classical education is a modern innovation.

During the latter half of the nineteenth century, the observations of nature-searchers made it possible to establish the general doctrine of the evolution of the cosmos, with more special detail in regard to the history of the earth and the development of man from a lower animal ancestry. The general process by which the higher and more elaborate forms of life, and eventually man himself, have been produced was shown by Darwin to depend upon heredity and variation. By the process of natural selection, those organisms survive which are most fitted to the special conditions under which they live. Man eventually emerged from the terrestrial animal population strictly controlled and moulded by natural selection. The leading feature in the development and separation of man from other animals is the relatively large size of his brain, which has five or six times the bulk (in proportion to his size and weight) of that of any other surviving Simian. The development of the mental qualities has given rise to attributes which are peculiar to man, and justify the view that man forms a new departure in the gradual unfolding of nature's predestined scheme.

"Civilised man has proceeded so far in his interference with extra-human nature, has produced for himself and the living organisms associated with him such a special state of things by his rebellion against natural selection and his defiance of nature's pre-human dispositions, that he must either go on and acquire firmer control of the conditions or perish miserably by the vengeance certain to fall on the half-hearted meddler in great affairs." It is practically certain that all epidemic disease could be abolished within a period so short as fifty years if the State cared to take the matter in hand and employ the means at the command of science. If more men were encouraged to study and experiment on this matter, there would soon be an end of all infectious disease.

By the exercise of his will, man has done much to control the order of nature, and it is urgent for him to apply his whole strength and capacity in gaining further control. Little, however, is being done in this direction, but when a knowledge of the situation reaches the masses of the people, "the democracy will demand that those who expend the resources of the community, and as Government officials undertake the organisation of the defence and other great public services for the common good, shall put into practice the power of nature-control which has been gained by mankind, and shall exert every sinew to obtain more. To effect this, the democracy will demand that those who carry on public affairs shall not be persons solely acquainted with the elegant fancies and stories of past ages, but shall be trained in the acquisition of natural knowledge and keenly active in the skilful application of nature-control to the development of the well-being of the community."

The concluding subject of the lecture was the influence exerted by the University of Oxford upon the welfare of the State and of the human community in general. Oxford by its present action in regard to the choice of subjects of study "is exercising an injurious influence upon the education of the country, and especially upon the education of those who will hereafter occupy positions of influence, and will largely determine both the action of the State and the education and opinions of those who will in turn succeed them." Is it desirable to continue to make the study of two dead languages the main, if not the exclusive, matter to which the minds of the youth of the well-to-do class are directed by our schools and universities? In view of modern needs it would be more sensible to make the chief subject of education for everybody "a knowledge of nature as set forth in the sciences, which are spoken of as physics, chemistry, geology, and biology." The ablest youths of the country should be encouraged to proceed to the extreme limit of present knowledge of one of these branches of science so that they might become makers of new knowledge, and the possible discoverers of enduring improvements in our control of nature. The great prizes of life ought to be given to the young man who pursues nature-knowledge successfully rather than to him who takes up less important subjects. In other words, it is desirable that our scheme of education should centre round a knowledge of nature and not continue to be mainly classical and historical.

Though men of science would make natural knowledge the core of education, they would consider it incomplete if a serviceable knowledge of foreign languages, and a real acquaintance with the beauties of English and other literature, were not added. "The studies of the past carried on at Oxford have been charming and full of beauty, whilst England has lain, and lies, in mortal peril for lack of knowledge of nature."

The suggestion "that Oxford should resign herself to the overwhelming predominance given to the study of ancient elegance and historic wisdom within her walls" is an insult to her and an impossibility. Only a few decades have passed since Oxford sent out Robert Boyle and Christopher Wren. Moreover, Oxford exerts an immense influence on the schools, and for this reason men of science cannot be content with the maintenance by the university of the compulsory study of Greek and Latin, and the neglect to make the study of nature an integral and predominant part of every man's education. For "the knowledge and control of nature is man's destiny and his greatest need."

SCIENCE AND THE STATE.

THE seventh of the series of weekly pamphlets which are appearing under the editorship of Mr. W. T. Stead, with the general title of "Coming Men on Coming Questions," is by Mr. R. B. Haldane, and is entitled "The Executive Brain of the British Empire." Mr. Haldane is an enthusiast for higher education. He is a thorough believer in the policy which has been advocated

consistently by NATURE, that the surest and best way to secure national efficiency is to educate our manufacturers and merchants liberally along scientific lines, and to enlist the cooperation of distinguished men of science in the work of national administration.

In considering the task that lies before a progressive political party, Mr. Haldane has much of interest to the man of science to say about things the party has to accomplish in the process of winning complete public confidence in its capacity to direct national business. He points out that the importance of each Department of State depends mainly on the personality of the Minister who presides over it. But apart from personality there are other forces —such as clear conception and resolute purpose—which profoundly affect administration. To bring into play greater brain power in administration is, Mr. Haldane insists, a task of the first magnitude, and he proceeds to show its importance and how it may be accomplished.

The appointment of the Explosives Committee by Lord Lansdowne in 1900 is the first illustration taken by Mr. Haldane. After the outbreak of the South African war, it came to light that the British military and naval guns were being corroded rapidly by the chemical action at high temperatures of the products of combustion of the nitroglycerin in the cordite. Lord Lansdowne, who summoned outsiders to advise him, was told that an expert committee on the national explosives required the best scientific brains in the country, and, following the earlier example in France, a committee, presided over by Lord Rayleigh and including Sir Andrew Noble and Sir William Crookes, was appointed. The committee has solved the problems presented to it, made further discoveries, and is now a permanent body. But the committee is performing its work under great difficulties, due entirely to our system of administration. As Mr. Haldane says, "the Army gives its rewards to genius on the field, and not to genius in the laboratory." He says later:—"If the British Government is to have adequate command of scientific talent of the highest order, it must make arrangements which will enable it to reward and honour that talent on an adequate scale, without exciting ill-feeling."

There ought, in fact, Mr. Haldane contends, to be an advisory body with a *corps scientifique* attached to it, which should include the exceptional talent which the State stands more and more in need of every day. Not only would such a scientific committee provide a new opening for talent, but, more important, prove a source of new strength to the nation. As a further instance of the good results which promptly follow the application of scientific methods to national problems, Mr. Haldane cites the case of the discovery among miners of the disease ankylostomiasis, after the Home Office had obtained the permission of the Treasury to appoint a committee of investigation, and indicates how great would have been the saving of suffering and money had there been a *corps scientifique* to appeal to as a matter of course.

Referring to the fall in the amount of exports in some branches of industry, Mr. Haldane traces this to the need for more mind in the process of manufacture, that is, for the improvement of higher education in this country, and goes on to remark that comparatively little State aid has been devoted to this important necessity. Exception is taken, too, to the somewhat mechanical methods of distribution of the present grant from the Treasury to university colleges, and it is urged that in this direction also the executive brain ought to be strengthened.

The Centralstelle of Germany, the function of which is to put at the disposal of inquirers, in the solution of problems arising in manufacture, the best scientific knowledge available which cannot otherwise be obtained by the private manufacturer, is an example of Germany's appreciation of men of science. Not only are such central research institutions established in Germany, but also in the United States and in France. The same principle has been conceded among us, for the State gives a small grant —just about a tenth of what the Germans give to their corresponding institution—to the National Physical Laboratory, an invaluable institution which is at present being starved. Well may Mr. Haldane say that "it is time for the State to take the lead in this direction also, if we are to hold our own in the international competition which is more and more coming to depend on the application of science to industry."

The essay as a whole is a powerful plea for the introduction of the methods of science into every department of national life, and should convince every reader that disregard of scientific method and procedure is of necessity accompanied by a want of national efficiency and wellbeing.

CORAL ANATOMY AND DEVELOPMENT.[1]

IN writing this account of his observations and researches on Siderastræa, Dr. Duerden has added an important contribution to his already extensive publications on the anatomy and development of the Madreporaria. Siderastræa is a common West Indian coral forming colonies of 10 cm. to 60 cm. in diameter, which encrust stones and sometimes the shells of hermit crabs on the coral flats. It appears to be exceedingly hardy, as it will suffer exposure to the hot sun at low tide and partial burying in the mud without injury, and it is often found living under conditions on the reef which very few corals of other species could withstand. This hardiness renders it an admirable type for thorough investigation, as it enables it to live and grow and reproduce itself freely in the unfavourable conditions of an aquarium in the tropics.

Siderastræa, although a colonial coral having a general superficial resemblance to the Astræidæ, or star corals, is allied to the Fungidæ, or mushroom corals. The tissues of the expanded zooids are so transparent that the white

FIG. 1.—Three larvæ of Siderastræa settling down upon a stone, in close proximity, by their narrow aboral poles.

skeletal structures can be seen through them. Each zooid has, in the adult state, two rows of capitate tentacles, and several of the members of the inner row are bifurcate. This remarkable and, among corals, unique condition of the tentacle is brought about by the growth of a common peduncle for a pair of neighbouring tentacles of the entocœlic series which are primarily distinct.

In all the zooids that were examined anatomically only ova were found; Dr. Duerden, however, gives reasons for believing that the coral is not strictly diœcious, but protogynous, a point of some interest when compared with the case of *Flabellum rubrum*, which Mr. Stanley Gardiner has shown to be protandrous.

The early stages of the development of the coral take place within the cavity of the parent zooid, and the ciliated top-shaped larvæ are discharged with four pairs of mesenteries already developed. The larvæ can be kept alive in the aquaria for several weeks, but unless they settle down within the first two or three days from liberation it seems impossible for them to fix themselves, and they ultimately perish. In general the larvæ fix themselves at the same time and in groups. So close do they cluster together that they are often in touch with one another,

[1] "The Coral *Siderastraea radians* and its Post-larval Development." By Dr. J. E. Duerden. Pp. 130+plates. (Washington: Carnegie Institution, December, 1904.)

and by mutual pressure produce a distortion of the normally circular base. There can be no doubt that in this coral, as in others investigated by Dr. Duerden, these clusters of larvæ become organically connected, and form aggregated colonies.

In dealing with the later stages of the development, the author discusses many questions of great interest to those who have made a special study of the anatomy of corals. We may refer especially to the light thrown upon the vexed question of "theca" and "epitheca," to the demonstration that the primary ectosepta do not become entosepta as they were supposed to do in some other corals, and to the valuable suggestion as to the scientific method of writing the septal formulæ of corals. These and other matters, which are fully discussed, render the memoir of greater value than a mere record of facts and observations of the natural history of a single species of coral would be. There is a great deal to be said in favour of the old type system, the system of presenting to the reader a plain, unvarnished tale of the natural history of a species and leaving him to draw his own conclusions; but the dangers of the system may be clearly recognised

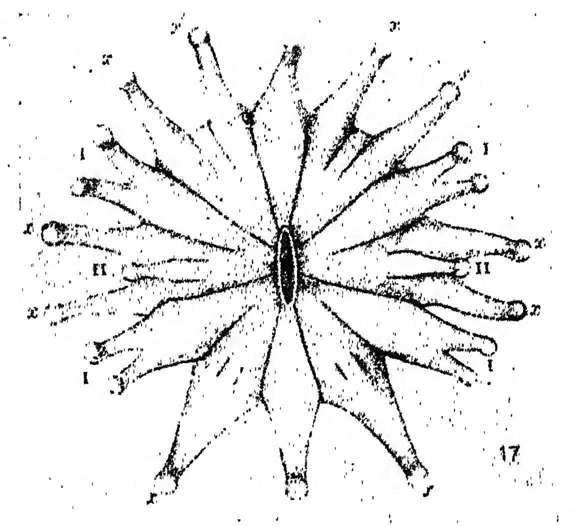

FIG. 2.—The disc of a young Zooid of Siderastræa with expanded tentacles showing (I.I.) the four bifurcate tentacles of the inner row.

in this memoir. The coral under review is a common, and many might think a common-place, coral, and if the author had thought fit to limit himself to a description of facts only, it would probably have been chosen as a type of its order by writers of the conventional text-book. Fortunately, however, we are warned on almost every page that Siderastræa is not a type, but in many respects an exceptional and rather archaic form.

In conclusion, a word of praise must be said for the manner in which the memoir is presented to the public. Like the other scientific treatises that have been recently published by the Carnegie Institution at Washington, the paper, printing, and illustrations are all of first-rate quality.

S. J. H.

GAS CALORIMETRY.

IN the recent report of the Departmental Committee appointed to consider the question of the control of the gas supply of the metropolis, a proposal was made that the calorific power of the gas should be regularly determined, thus recognising the growing importance of the heating value of gas as distinguished from its illuminating power. The use of gaseous fuel both for heating and power purposes having led to a demand for exact gas calorimetry, several types of calorimeter have come into use. In those of the Junker type, the gas is burned at a measured rate, and the products of combustion are cooled down by a stream of water also flowing at a known rate, the ingoing and outgoing temperatures of which can be accurately measured. In spite of the difficulties of securing accurate measurements of the rate of flow of gas and water, on account of the speed with which consecutive determinations can be carried out instruments of this type are mostly used by gas engineers. Their chief defect is want of portability, and as an alternative a sample of the gas is frequently analysed, and the calorific value deduced from the results of the analysis. Apart from the difficulty of exactly determining the constituents of such a complicated mixture as coal gas, this method implies that the exact calorific value of each substance present is accurately known, and this, unfortunately, is far from being the case.

Most of the data regarding heats of combustion in actual use are derived either from the experiments of Berthelot and his pupils with the calorimetric bomb, or from the experiments of Julius Thomsen, and in the case of gaseous substances the differences between these two experimenters may amount to as much as 2 per cent. In the current number of the *Zeitschrift für physikalische Chemie* Julius Thomsen has a critical paper on the causes of these differences, and comes to the conclusion that for gases the explosion with compressed oxygen in a bomb gives quite untrustworthy results. His chief argument is based on the comparison of the values obtained for the heats of combustion of homologous series of hydrocarbons and their halogen derivatives, and it is shown that whereas the method of combustion at ordinary atmospheric pressure gives remarkably constant differences between the consecutive members of such a series, the results obtained by means of the calorimetric bomb lead to differences between consecutive members which are quite irregular. It follows that the values obtained for heats of formation, which lie at the basis of all theoretical speculations in this field, are still more irregular in the case of figures obtained with the bomb, since they are based on the differences between the heats of combustion. The weak point in most physical work on gases is usually on the chemical side, and on account of the extreme practical and theoretical importance of the subject and the great advances made in the last ten years in the methods of preparation of pure gases, there is still room for a re-determination of these constants. In this connection it may be pointed out that the ultimate mode of calibration of gas calorimeters of the Junker type is the combustion of a known quantity of a pure gas the heat of combustion of which is taken as known.

G. N. H.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Prof. E. Ray Lankester for the degree of D.Sc. *honoris causa* on June 13:—

Salutat Academia nostra Edwinum Ray Lankester, alumnum suum. Hic ille est, cuius magna apud nos est memoria Anatomiæ Comparativæ cathedram olim tenentis, quod et discipulis ardorem suum miro modo inspirare potuit, et specimina in usum Musæi nostri diligentissime congesta ita novis rationibus collocavit ut Historiæ Naturalis principia luce clariore illustraret: qui hanc Academiam ut suos mores emendaret toties hortatus est, quæ ad inauditam perfectionem iamdudum pervenisset si monitori amicissimo in Actis Diurnis contionanti obtemperare voluisset. Hic est cuius ex repertis laudis aliquid ad suam Almam Matrem redundavit, cum inter insignissimos doctores qui hodie de animalium figuris disputant fere princeps sit et in omnibus virorum doctorum societatibus summo in honore habeatur.

Nihil profecto quod ad Anatomiam Comparativam pertinet non in huius viri scientiam cadere videtur. Neque enim huic satis erat edendi curam suscipere cum Acta illa, quæ summæ auctoritatis in hoc genere apud nos sunt, labore per quinque et triginta annos iam continuato, tum luculentissimorum librorum seriem, e quibus plures iam typis impressi in manibus omnium habentur, quod onus

pergrave videri plerisque potuit: sed de omnigenum animalium figuris et mutationibus, sive in ipsa mundi iuventa sive hodie exstantium, commentarios fere innumerabiles ipse conscripsit. Nullum est animalium genus de quo aliquid non scripserit, neque quicquam scripsit nisi præclare. In hoc viro admiramur cum summi artificis patientiam nullam rem tenuiorem esse docentis quam ut scientia dignum sit, tum doctrinam latissimam et subtilissimam nova inventa cum prioribus colligantis et suo quidque loco reponentis. Sed ulterius etiam progressus est. Quid enim? Incrementum fit scientiæ non solum ex indefessa diligentia et doctrina coacervata summorum veri indagatorum: quin ipsa diligentia et doctrina parum fertilis est nisi conclusiones ita verbis et tabulis expressæ sint ut in memoria nostra hæreant et novissimum quodque repertum suo loco residere patiantur. Veluti hic noster, qui iuvenis adhuc rationes a Ioanne Müllero et Huxleio excogitatas, quo melius omnia ad Historiam Naturalem pertinentia subtilissime litteris mandarent, se optime callere ostenderat, postea novos modos invenit, nova nomina commentatus est, veteres etiam rationes correxit et excoluit: quæ omnia iam adeo omnibus comprobata sunt ut nemo inquirat a quo fonte emanarint. Quod si ex hac præclara supellectili unam quasi margaritam potissimum sumere fas sit, eos commentarios singulari laude ornaverim, quibus Limulum illum aquatilem scorpiones et araneas terrestres inter se similes esse ostendit. Nihil profecto in hoc genere perfectius, nihil quod posterorum imitatione sit dignius.

Following the announcement in the *University Gazette*, the age limits in the examination to be held on August 29 for the selection of probationers for the Indian Forestry Service were stated in our note on June 8 (p. 139) to be from eighteen to twenty years on January 1, 1905; Prof. Schlich writes to point out that the correct age limits are from eighteen to twenty-one years on that date.

Dr. W. T. Brooks (Christ Church) has been appointed Litchfield clinical lecturer in medicine for two years from June.

A statute has been passed in Convocation establishing a diploma in anthropology, and providing a committee to organise the course of study in that subject, and to make regulations for the diploma examination. The committee will consist of seventeen members, including the professors of anthropology, comparative anatomy, moral and metaphysical philosophy, comparative philology, the reader in mental philosophy, the keeper of the Ashmolean Museum, and the curator of the Pitt Rivers Museum. Candidates who are not already members of the university will be admitted under the same conditions as candidates for the degrees of B.Litt. and B.Sc.

Magdalen College has announced a fellowship in chemistry, election to which will be made next October term after an examination. Further details will be published shortly.

CAMBRIDGE.—The following are the speeches delivered by the Public Orator, Dr. Sandys, on June 14, in presenting the two recipients of the degree of Doctor in Science *honoris causa*:—

CAPTAIN ROBERT FALCON SCOTT, R.N., C.V.O.

Poli australis e regione salvum sospitemque nobis redditum laetamur virum intrepidum, cui disciplina et gloria navalis ab avo velut hereditate obvenerat. Abhinc annos quinque navis magister designatus est, rerum naturae miraculis prope polum australem explorandis destinatae. Illic, primum terrae Victoriae montes asperos conspicatus, deinde ex transverso oppositum glaciei velut murum immensum diu praetervectus, tandem nivis aeternae regionem quandam excelsam detexit, detectam Regis Edwardi nomine nuncupavit. Quid commemorem navem illam prope montem Erebum, prope ipsa Volcani spiracula, glaciei solidae in mediis molibus per biennium compressam? Quid geographiae, geologiae, meteorologiae, biologiae denique in studiis, scientiarum fines, talium virorum auxilio, feliciter propagatos? Quid itinera longa glaciei perpetuae inter pericula tolerata? Tot virorum fortium de duce intrepido illud primum dixerim:—omnium mortalium nemo umquam ad ipsum polum australem propius penetravit. Deinde, "numquam" sociis suis "plus laboris imposuit quam sibi sumpsit; ipse cum fortis, tum etiam felix."

SIR FRANCIS YOUNGHUSBAND, K.C.I.E.

Hodie corona nostra suprema viro destinata est, qui matris suae fratrem, exploratorem indefessum, olim aemulatus, omnium mortalium solus, oceani Pacifici a litore trans Asiae mediae recessus intimos septem milia passuum milies emensus, montium formidolosorum per ambages prope inextricabiles, Indiae demum ad castra prima pervenit. Idem nuper, Britanniae legatus, cum copiis nostris fortissimis, Indiae per Alpes silvasque, post moras infinitas fortiter et prudenter devictas, per apertam portam, Tibetorum ad loca praecelsa ultra lacum illum caeruleum progressus, tandem, inter nemora late virentia, arcis summae tecta aurea conspicatus, religionis antiquissimae sedem sacram, tot laborum, tot itinerum metam ultimam, intravit. In legatione vero illa obeunda, viri huiusce potissimum auspicio, terrae spatia immensa accuratissime explorata sunt; fluminum ingentium cursus patefacti; saeculorum denique priorum monumenta plurima aut intacta relicta aut diligenter conservata. Iuvat autem recordari regionem illam remotissimam cum exercitu nostro legatum nostrum ita peragrasse, ut nullum crudelitatis, nullum inhumanitatis vestigium reliquerit, sed benevolentiae mutuae, etiam foedere ipso potioris, fundamentum iecerit.

Mr. E. T. Whittaker, of Trinity College, has been appointed a university lecturer in mathematics.

The Home Secretary has approved the university for the purposes of the Coal Mines Regulation Act (1887) Amendment Act, 1903, in respect of its diploma in mining engineering.

The Harkness scholarship in geology and palæontology has been awarded to Mr. F. A. Potts, of Trinity Hall, and the Wiltshire prize for geology and mineralogy to Mr. A. McDonald, of Emmanuel College.

The treasurer to the Sedgwick memorial fund, which was inaugurated in the Senate House on March 25, 1873, has issued a final balance sheet. The original subscription list amounted to 11,157*l*. 1*s*. 6*d*., and this sum increased by investment to 27,453*l*. 2*s*. 4*d*. A thousand guineas were spent on the bronze statue of Sedgwick, and 26,125*l*. on the Sedgwick Museum; the balance was mainly expended on printing, but a small sum left over has been paid to the financial board.

DR. JAMES GOW will distribute the certificates and prizes at King's College, London, on Wednesday, July 5. The museums and laboratories of the college will be open to visitors upon this occasion.

DR. A. B. W. KENNEDY, F.R.S., will deliver the foundation oration of the Union Society of University College, London, on June 29; his subject will be "The Academic Side of Technical Training."

AMONG the honorary degrees accepted by the Senate of the University of Dublin on June 17 was the degree of Sc.D. to be conferred on Prof. E. A. Schäfer, F.R.S., and on Prof. Sydney Young, F.R.S.

MR. G. F. CARSON, formerly on the staff of the University College, Sheffield, has been appointed head of the department of mathematics in Battersea Polytechnic, and Miss Lilian J. Clarke has been appointed lecturer in botany.

AT the entrance examination for the day courses in engineering to be held next September, the governing body of the Northampton Institute, Clerkenwell, has decided to offer three scholarships for open competition. These scholarships will give exemption from fees, amounting to 52*l*., during the whole of the four years' course in mechanical or electrical engineering.

DURING December next, in the department of physics of the Columbia University, New York City, a course of fifteen lectures will be delivered by Prof. V. F. Bjerknes, professor of mechanics and mathematical physics in the University of Stockholm. The subject will be "Fields of Force," including the discussion of hydrodynamic analogies of the electrostatic and electromagnetic fields. A similar

course will be delivered in March and April, 1906, by Prof. H. A. Lorentz, professor of physics in the University of Leyden.

Under the title "The Education of the Examiner," Dr. Charles E. Fawsitt publishes, in the *Proceedings of the Royal Philosophical Society of Glasgow*, an interesting note on the statistics of examination marks as revealed by graphic methods. Most examiners who have had to draw curves showing the distribution of marks in any examination know the difficulty of obtaining an even uniform curve rising continuously to a maximum and then descending continuously. However carefully the scale of marking is adjusted, the curve has an unpleasant habit of showing two maxima, usually of unequal height, instead of the one maximum of the generally recognised standard curve. Dr. Fawsitt, as the result of observations on class examinations conducted at Edinburgh, brings forward the welcome suggestion that this irregularity is not the fault of the examiner, but is due to the fact that the candidates naturally divide themselves into two sets, namely, workers and non-workers, and that while the students in either set vary in every conceivable way in respect of *ability*, a marked line of division is drawn with regard to work. The superposition of two error curves, in accordance with this theory, gives results closely agreeing with those of common experience.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 16.—"On the Dimorphism of the English Species of Nummulites, and the Size of the Megalosphere in relation to that of the Microspheric and Megalospheric Tests in this Genus." By J. J. **Lister**, F.R.S.

The results obtained in this investigation are summarised as follows:—

(1) Both microspheric and megalospheric forms of *N. variolarius* and *N. Orbignyi* var. *elegans* are present in the Eocene beds of the Isle of Wight and Hampshire, as the author believes they will be found to be present elsewhere, except when the materials of a bed have been re-arranged under the influence of currents.

(2) In these species and in *N. laevigatus* and *N. gizehensis* the size of the microsphere is nearly constant—the diameters in the specimens measured being between 15 μ and 20 μ.

(3) In the nine species and one variety of Nummulites which the author has examined, the size of the megalosphere is approximately proportional to the volume of the contents of the microspheric form.

By this result additional proof is given of de la Harpe's conclusion, founded on the mode of occurrence in the beds, and on structural features of the tests of the two forms, that these are in each case truly members of "a pair," or, as we now say, are related as alternating or recurring forms in the life-history of a species.

By (2) and (3) the two modes of reproduction come into marked contrast, the asexually produced megalospheres being proportional in size to the protoplasmic volume of the parent, while the microsphere, probably arising as a zygote, is uniformly small throughout.

(4) In several of the species examined, as the microspheric member of the cycle preponderates in the life-history, the megalospheric (or gamete-producing) member decreases, not only in proportion to the size of the microspheric form, but in proportion to the megalospheric members of other species in which the two forms attain approximately equal sizes.

April 6.—"Ovulation and Degeneration of Ova in the Rabbit." By Walter **Heape**. Communicated by Adam Sedgwick, F.R.S.

This paper is an abstract of several years' experimental work. The growth of the graafian vesicle and ovum, and the modification of the adjoining ovarian tissue, are referred to. The maturation of the ovum takes place in the ovary. It is dependent upon coition, and follows a cessation of the supply of nutriment to the ovum. Ovulation occurs ten hours after copulation, and does not occur if coition is prevented.

The cause of the rupture of the graafian vesicle is probably due to the stimulation of ovarian contractile tissue, to effect which, in the domestic rabbit, the excitement of sexual contact appears to be necessary.

The prevention of coition results in the degeneration of ripe follicles, and the production of false corpora lutea. Such degenerate follicles do not rupture, and the ovum contained therein is not discharged. The structure and fate of the true and false corpora lutea are briefly described.

The persistent prevention of breeding causes degeneration of young as well as ripe follicles on a large scale, and results in more or less obstinate sterility.

Degeneration of young follicles occurs normally. While this may be due to want of nutriment, caused by competition of neighbouring follicles, it may also be due to incapacity to assimilate the nutriment which is supplied.

In this latter case, failure is due to a peculiarity in the constitution of the ovum, constituting it a "sport." As there is evidence that the production of variable offspring depends upon the quality or quantity of nutriment supplied to the mother, it is urged that the study of nutrition from this point of view becomes a matter of very great interest and importance to students of heredity.

A brief review of the evidence concerning the forces which influence breeding results in the conclusion that changes are induced in the constitution of the blood by means of a "generative ferment" of extraneous origin; the effect of which upon the generative glands causes their secretion of "gonadin," which exercises a profound effect upon the rest of the generative system.

"On the Nature of the Silver Reaction in Animal and Vegetable Tissues." By Prof. A. B. **Macallum**.

When fresh preparations of animal and vegetable tissues are treated with a solution of nitrate of silver containing free nitric acid and then exposed to light, they become coloured, the colour varying in intensity and tint. The author endeavoured to determine to what the reaction is due, and how far one may go in employing it for microchemical purposes. It was found that of the organic constituents of tissues, the only ones which form compounds with silver "reducible" under the action of light are sulphocyanic acid, creatin, and taurin. As creatin is present only in vertebrate muscle fibre, and not at all in invertebrates, while the other compounds mentioned occur in tissues only in infinitesimal, and, therefore, in negligible, quantities, the silver reaction cannot be attributed to their presence. It was further ascertained that neither phosphates, carbonates, nor sulphates give "reducible" silver compounds in the presence of free nitric acid. There remained, among organic compounds in tissues, only the proteids, and as these have been, and are, generally held to form, with silver salts, compounds which are "reduced" in light, it was necessary to determine whether the coloured compounds so formed are "albuminates" or simply the subchloride of silver. For this purpose proteids were freed from chlorides by repeated precipitation with pure ammonium sulphate, and it was found that egg and serum albumins and globulins, as well as the gelatins, after the eighth precipitation give no colour reaction whatever with nitrate of silver under the influence of light, and that the compounds eliminated by the precipitation, and to which the silver reaction is due, are chlorides. Nucleo-proteids also were found to be reactionless. In the case of vegetable proteids the methods employed were different, but the result was the same. Silver nitrate may, consequently, be used as a microchemical reagent for determining the presence of chlorides in animal and vegetable tissues, and its use for this purpose has already furnished some important results. Amongst these may be mentioned the absolute freedom of the nucleus from chlorides, the absence of the latter from the head of the spermatozoon, and the demonstration that they alone are the cause of the silver reaction in the "cement substance" (of von Recklinghausen) as well as in ordinary cell protoplasm.

May 18.—"Reciprocal Innervation of Antagonistic Muscles." Eighth Note. By Prof. C. S. **Sherrington**, F.R.S.

Exhibition of strychnine converts reflex inhibition of muscles into excitation; so also, more gradually, but just as potently, does *tetanus-toxin*. This conversion sets in before and under smaller doses of strychnine or toxin than are required to produce the convulsive seizures characteristic of strychnine poisoning or general tetanus.

The conversion of inhibitory effect into excitation effect by strychnine is more easily obtained in the case of some nerves than of others.

The conversion of spinal inhibition into excitation by strychnine explains the simultaneous contraction of large inharmonious groups of muscles in strychnine convulsions. It also explains the occurrence, under a given stimulus of reflex contraction, of muscles that previously do not seem, under superficial examination, to be reached by the reaction. These muscles are really included in the reflex effect normally, but the effect on them then being *inhibition*, it passes unnoticed, unless special means are adopted for seeing it. Thus, in the ordinary "flexion reflex," initiated, say, from the right foot, the flexion of the homonymous knee is easily seen to be due to contraction of its flexor muscles, also the concomitant extension of the crossed knee is easily seen to be due to contraction of its extensor muscles. But it requires special preparations to detect that, with the contraction of the right knee-flexors, there goes reflex inhibition of the right extensor, and that, with the contraction of the left knee-extensor, there goes reflex inhibition of the left knee-flexors. This being so, when under strychnine, the reflex is suddenly changed in character, both flexors and extensors being in both legs thrown into contraction together, it appears to an observer, unaware of the previous inhibitions, that, under the strychnine, the reflex action reached muscles which it did not reach before, *e.g.* right knee-extensor and left knee-flexor. Hence arises the hypothesis that the alkaloid breaks down a supposed spinal "resistance," previously intervening between the afferent nerves and various motor spinal cells ordinarily inaccessible to them. Strychnine does lower the threshold stimulus for spinal reflexes at one stage of its action; but the central fact of strychnine effect appears to the author that it destroys spinal taxis for the skeletal musculature by upsetting the fundamental coordination of reciprocal innervation. It upsets reciprocal innervation because it transforms inhibition into excitation.

On the view advanced in these notes previously that the cortex of the brain exercises reciprocal innervation of antagonistic muscles, strychnine and tetanus-toxin should transform the functional topography of the "motor" cortex. This on examination proves to be the case.

Strychnine and tetanus-toxin change cortical flexion of leg and arm into extension. Reflex "opening" of the jaw is in the decerebrate animal converted into reflex closure by tetanus-toxin and by strychnine, the inhibition of the predominantly powerful closing muscles being converted into excitation of them.

Similarly, when the "face-area" of the monkey's cortex is tested by faradisation after exhibition of strychnine or tetanus-toxin, the points of surface that, prior to the drug, yield regularly the free opening of the jaw, yield strong closure of the jaw instead. Closure of the jaw is, comparatively, an infrequent movement to obtain from the cortex of the monkey. On the other hand, *opening* of the jaw is always readily and regularly elicitable from a large field of the "face-area." Under tetanus toxin and strychnine the whole of this area not only ceases to yield opening of the jaws, either maintained or rhythmic, but yields closing of them instead.

The foregoing observations give an insight into the essential nature of the condition brought about by tetanus and by strychnine poisoning. These disorders work havoc with the coordinating mechanisms of the central nervous system, because, in regard to certain great groups of musculature, they change the reciprocal inhibitions, normally assured by the central nervous mechanisms, into excitations. The sufferer is subjected to a disorder of coordination which, though not necessarily of itself accompanied by physical pain, inflicts on the mind, which still remains clear, a torture inexpressibly distressing. Each attempt to execute certain muscular acts of vital importance, such as the taking of food, is defeated because exactly the opposite act to that intended results from the attempt. The endeavour to open the jaw to take food or drink induces closure of the jaw, because the normal inhibition of the stronger set of muscles—the closing muscles—is by the agent converted into excitation of them. Moreover, the various reflex arcs that cause inhibition of these muscles not only cause excitation of them instead, but are, periodically or more or less constantly, in a state of hyper-excitement, and yet attempt on the part of the sufferer to restrain, to inhibit, their reflex reaction, instead of relaxing them, only heightens their excitation further, and thus exacerbates a rigidity or a convulsion already in progress.

"The Structure and Function of Nerve Fibres.—Preliminary Communication." By Prof. J. S. **Macdonald**. Communicated by Prof. C. S. Sherrington, F.R.S.

In contradiction to certain conclusions[1] arrived at by the author as a consequence of his experimental observation of the "injury current" of nerve, it has recently been denied[2] that inorganic salts occur in any appreciable quantity within the internal structure of the nerve-fibre. This conclusion has been formed as the result of observations made with the use of a reagent—cobalt nitrite—which precipitates potassium salts in a manner open to investigation with the microscope. It has been shown that the reagent does not give rise to precipitates at every point in the length of the nerve-fibre, but only at certain points of infrequent occurrence. The author has checked this statement, also using microscopical methods, and confirms it. He draws, however, an entirely different conclusion from these observations, since he has further observed that these points of infrequent occurrence are points at which the axis-cylinder has been injured in the course of preparation. He concludes that potassium salts are really present in very considerable quantity uniformly distributed along the axis-cylinder, but that they appear in a state of simple solution only at injured points.

The author directs attention to the possible general importance acquired by this observation, when account is taken of the parallelism between injury and "excitation." The sudden appearance of inorganic salts (electrolytes) in a state of simple aqueous solution at an excited point means a transitory increase in local osmotic pressure, new processes of diffusion, and disturbances of electrical potential. In this he sees a sufficient explanation of nerve-conduction. In the case of muscle, also, the influence of similar phenomena is considered, and a possible relation between such an increase in local osmotic pressure and "contraction." He also refers to the possibility of the influence of this factor in the conditions determining the flow of water in plant structures.

June 8.—"The Perturbations of the Bielid Meteors." By Dr. A. M. W. **Downing**, F.R.S.

As the general result of the calculations described in this paper, it appears that the most probable date for the centre of a shower of Bielid meteors this year is November 18, 10h., G.M.T. If there be a shower at that date, it will indicate that the meteor stream is, in this part, of sufficient length to occupy at least thirty-three days (October 16 to November 18) in passing a definite point in its orbit—or that there is another swarm following the main swarm at this interval—and is also of sufficient extent in the direction sun-earth to allow of some of the meteors encountering the earth, although the centre of the stream is more than 1,000,000 miles outside the earth's orbit at the time.

"Chitin in the Carapace of *Pterygotus osiliensis*, from the Silurian of Oesel." By Dr. Otto **Rosenheim**. Communicated by Prof. W. D. Halliburton, F.R.S.

Fragments of the carapace of certain fossil Eurypterids found in Oesel in rocks of Silurian age, from specimens

[1] J. S. Macdonald, "Thompson-Yates Laboratory Reports," vol. iv., part ii., pp. 213–348, 1902; *Proc. Roy. Soc.*, vol. lxvii., pp. 315–324; *ibid.*, pp. 325–328; *Proc. Physiol. Soc.*, December 17, 1904; *ibid.*, March 18, 1905.

[2] A. B. Macallum, *Journal of Physiology*, vol. xxxii. p. 1.

in the British Museum (Natural History), have been examined by the author for chitin.

The conclusion drawn from the experiments is that the general behaviour of the substance towards acids and solvents is such that it is probably chitin, and this is confirmed by the fact that, after such treatment, it yielded, on hydrolysis with concentrated hydrochloric acid, a strongly reducing substance which is presumably glucosamine.

"On the Magnetic Qualities of some Alloys not Containing Iron." By Prof. J. A. **Fleming**, F.R.S., and R. A. **Hadfield**.

For the purposes of exact magnetic measurements two homogeneous rings of regular form of alloys not containing iron were made at the Hadfield Steel Works, Sheffield, and sent to the Pender Electric Laboratory of University College, London. These two rings were respectively numbered No. 1871 and No. 1888/7. The ring No. 1871 had the following composition:—manganese, 22·42 per cent.; copper, 60·49 per cent.; aluminium, 11·65 per cent. There is a certain amount of intermingled slag, probably 2 per cent. or 3 per cent., mostly consisting of MnO and SiO_2 and slight traces of other metals. Analysis showed that there was present also:—carbon, 1·5 per cent.; silicon, 0·37 per cent.; and iron, 0·21 per cent. Hence it may be said that nothing but a trace of iron occurs in this sample of alloy. The other ring, No. 1888/7, had an approximate composition:—manganese, 18 per cent.; copper, 68 per cent.; aluminium, 10 per. cent.; lead, 4 per cent. These alloys unfortunately have poor mechanical properties and are brittle and cannot be forged. Rings were cast from the material and turned in the lathe to the desired form.

From the observations the following conclusions are drawn:—

(1) The alloy No. 1871, composed of copper, aluminium, and manganese in the proportion mentioned above, exhibits magnetic properties which are identical with those of a feebly ferro-magnetic material. (2) The magnetisation (or B, H) curve is of the same general form as that of a ferro-magnetic metal such as cast iron, and indicates that with a sufficient force, a state of magnetic saturation would most probably be attained. (3) The alloy exhibits the phenomenon of magnetic hysteresis. It requires work to reverse the magnetisation of the material and to carry it through a magnetic cycle. (4) The material has a maximum permeability of 28 to 30, which is not greatly inferior to that of the values reached for cobalt or a low grade of cast iron for small magnetic forces, and occupies a position intermediate between the permeability of the ferro-magnetic and the merely para-magnetic bodies, such as liquid oxygen and ferric chloride. (5) The material exhibits, therefore, the phenomenon of magnetic retentivity and coercivity. It is not merely magnetic, but can be permanently magnetised.

The authors are led by these results to conclude that the magnetic properties of this alloy must be based on a certain similarity of molecular structure with the familiar ferro-magnetic metals.

Experiments on the magnetic qualities of the alloy No. 1888/7 give results similar to those of the alloy No. 1871. For both alloys No. 1871 and No. 1888/7 the hysteretic exponents are not very different, being respectively 2·238 and 2·288, whereas the hysteretic constants are very different, being respectively 0·0005495 and 0·000776. It is clear, therefore, that both these alloys, although magnetic, have far greater hysteresis than pure iron, nickel, or cobalt for corresponding cycles of magnetisation.

"Note Supplementary to a Paper 'On the Radio-active Minerals.'" By the Hon. R. J. **Strutt**, F.R.S.

In a paper read before the society on February 28, the author directed attention to the fact that all thorium minerals, so far as could be ascertained, appeared to contain uranium and radium. Since then he has examined a number of additional minerals, in order to test the induction further. The result has been quite confirmatory of the original conclusion. The author, in this further investigation, contented himself with determining the thorium and radium, for it may now be considered proved that radium is a product of uranium, and it is much easier to establish the presence of radium by its emanation than to detect uranium by chemical analysis. The experimental methods explained in the former paper were employed. The results are as follows:—

Mineral	Locality	Thorium oxide, per cent.	Radium, millionths of 1 per cent.
Thorite ...	Ceylon	61·0	1·00
,, ...	Brevig, Sweden ...	53·9	0·81
Monazite ...	Johannesberg	5·94	1·06
Alvite	Raade Moss, Norway	4·95	1·81
Xenotime ...	,, ,,	3·89	0·90
Monazite ...	N. Carolina[1]	3·79	0·53
,, ...	Nigeria	2·98	3·78
Anerodite? ...	Ceylon	2·27	9·80
Monazite ...	Malay Straits	1·53	4·02
Fergusonite	?	1·31	26·7
Malacone ...	Hitteroe, Norway ...	1·15	1·40
Allanite ...	Amherst Co., Virginia	0·492	1·08
Yttrotantalite	Ytterby, Sweden ...	0·437	5·56
Polycrase ...	?	0·334	0·36
Zircon	N. Carolina	0·307	0·34
,,	Virginia	0·217	0·52

1 This consisted of pure grains of monazite, picked out from the commercial sand.

Mathematical Society, June 8.—Prof. A. R. Forsyth, president, and temporarily Prof. W. Burnside, vice-president, in the chair.—On the conditions of reducibility of any group of linear substitutions, and On criteria for the finiteness of the order of a group of linear substitutions: Prof. W. **Burnside**. In the first of these papers it is proved that a group of linear substitutions on a finite number of symbols is reducible if, and not unless, one or more linear equations holds between the coefficients of every substitution of the group. In the second paper it is shown that in order that a group of linear substitutions may be of finite order it is necessary that both the real part and the imaginary part of every coefficient should lie between two fixed assignable numbers, and this condition is sufficient.—On a class of many-valued functions defined by a definite integral: G. H. **Hardy**. The integral

$$\int_0^\infty \frac{e^{-u^\lambda}\, u^{a-1}}{u+x}\, du$$

is a many-valued function of x having no singularities save $x=0$, and the behaviour of the function depends on the character of a and λ as rational, algebraic or transcendental numbers. In a number of cases the function can be represented in the neighbourhood of the singular point by a convergent combination of two divergent power series.—Informal communications were made as follows:—The first principles of Cauchy's theory of functions: G. H. **Hardy**.—On differential equations whose integrals are expressible by partial quadratures: Prof. A. R. **Forsyth**.

Royal Astronomical Society, June 9.—Mr. W. H. Maw, president, in the chair.—The discordant values of the principal elliptic coefficients in the moon's longitude: P. H. **Cowell**.—Determination of heat radiation from the moon: the **Earl of Rosse**. The author had found that the lunar heat varied with the phase, that it was negligible at new moon, and attained its maximum at full moon. He considered it a surface heat, not regularly *reflected*, but absorbed and re-emitted. Suggestions were made for future observations during lunar eclipses. Prof. Turner stated that the maximum at full moon might indicate that some of the heat was reflected.—The diurnal variations of nadir and level of the Greenwich transit circle: **Astronomer Royal**. The variation of the level has a period of twenty-four hours, with a maximum about 6 a.m.

and a minimum about 6 p.m. The variations of nadir are much smaller, and do not show any conclusive result except a discordance near 6 p.m.—On the determination of stellar proper motions without reference to meridian places: A. R. **Hinks.**—The meteors from Biela's comet: W. F. **Denning** and Dr. **Downing.**—General scheme for determinations of stellar parallax from photographs taken at the Cambridge Observatory: A. R. **Hinks** and Dr. H. N. **Russell.** A brief account was also given of results already obtained for the parallax of Lalande 21185 and γ Virginis.

Zoological Society, June 6.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Specimen of a new bushbuck, which it is proposed to call *Tragelaphus haywoodi*, sp. n.: O. **Thomas.** Mr. Thomas also exhibited some mammals and birds from Japan obtained by a collector sent out by the society's president, the Duke of Bedford, K.G., who proposed to further zoological science by having systematic collections made in that part of the world. Of the present series Mr. Thomas directed attention to a fine marten, different from the true *Mustela melampus*, and which he proposed to call *Mustela melampus bedfordi*, subsp. n.—On the intestinal tract of mammals: Dr. P. C. **Mitchell.** In the course of the last eight years, the author had taken every possible opportunity of studying the alimentary tract of mammals from specimens that had died in the society's gardens, and had obtained additional material elsewhere, with the result that his investigations covered more than two hundred individuals, and included the greater number of the mammalian orders. —The natural history of western Uganda, deduced from observations and collections made by the author while acting as British Boundary Commissioner on the Uganda frontiers: Lieut.-Colonel C. **Delmé-Radcliffe.**—Distribution of Mexican Amphibia and Reptilia: Dr. H. **Gadow.** After a critical revision of the species recorded from Mexico, the author stated that he grouped them according to the prevailing physical features of the country. It was found that Mexico had received its present fauna from both the northern and the southern continents. The northern immigrants had spread over high tablelands and mountains, whilst not a few species had descended into the hot lowlands, even into Central America and still further south. On the other hand, the southerners were divided by the plateau into an Atlantic and a Pacific mass, each having had time to modify many of its members according to the very different physical features. Scarcely any of these southerners had ascended the plateau, but they were not averse to ascending high outlying mountains. A comparative list of species confined to high altitudes was given, and the conclusion arrived at, with the help of geological data and the fauna of the Antilles, was that the exchange between the north and south took place during the Miocene epoch, at which period alone the Antilles were connected with Central America.—New species of reptiles discovered in Mexico by Dr. H. Gadow: G. A. **Boulenger.**—Batrachians and reptiles collected in South Africa by Mr. C. H. B. Grant and presented to the British Museum by Mr. C. D. Rudd: G. A. **Boulenger.**—Notes on the anatomy of the yellow-throated lizard, *Gerrhosaurus flavigularis*: F. E. **Beddard.**—Notes on the cerebellum in the exanthematic monitor, *Varanus exanthematicus*, and on the cerebral hemispheres in the Taraguira lizard, *Tropidurus hispidus*: F. E. **Beddard.**—The fœtus and placenta of the spiny mouse, *Acomys cahirinus*: R. **Assheton.** —Some new Coleoptera from South Africa: Rev. H. S. **Gorham.** The beetles referred to were of the families Malacodermata, Cleridæ, and Erotylidæ, and had been collected by Dr. H. Brauns, of Willowmore, in Cape Colony, either at Willowmore or at Delagoa Bay in 1900 or 1901, and indicated that the fauna of South Africa was rich in species of the two first families, and more so than had been supposed in members of the latter family. One new genus was described.—Remarks on the supposed clavicle of the sauropodous dinosaur Diplodocus: Baron Francis **Nopcsa.**

EDINBURGH.

Royal Society, June 5.—Prof. Geikie in the chair.—The distribution of the nerve cells in the intermedio-lateral tract of the dorso-lumbar region of the human spinal cord: Dr. A. **Bruce.** The region was found to extend from the end of the upper third of the eighth cervical to the lower extremity of the second or, perhaps, the upper part of the third lumbar segment, and to occur, not as a continuous tract, but as clusters or groups of cells, separated in some of the upper and lower segments by distinct intervals in which there were no cells, but in the greater part of the dorsal region by incomplete intervals in which there were present a small number of cells. The clusters appeared to be arranged in a manner characteristic more or less of each segment, attaining their maximum number in the third dorsal. The cells lay in the white matter behind the lateral portion of the anterior cornua in the eighth cervical and first dorsal segments; below that point they occupied the apex of the lateral horn, and from the lower part of the second dorsal region they occupied also the grey matter subjacent to the formatio reticularis, and occasionally extending into the formatio reticularis itself. The clusters of cells in this, the reticular group, were frequently continuous with those at the apex of the horn, and belonged undoubtedly to the same system. It was found that the symmetry between the two sides of the cord was not quite complete.—The Tardigrada of the Scottish lochs: J. **Murray.** Twenty-one species were identified, of which six were considered new. It has been usual to distinguish species of Echiniscus by the number and arrangement of the spines and other processes, but in some of the species it was found that spines continue to increase in size at the moult, and that new ones may appear. Also one or two species lay eggs when hardly larger than larvæ, and at successive moults thereafter lay more and larger eggs. In the study of the order there is, in fact, great need for careful tracing of life-histories.—Report on the Medusæ found in the Firth of Clyde (1901–2), and notes on the pelagic fauna: E. T. **Browne.** The report deals with thirty species of Hydromedusæ and five species of Scyphomedusæ, most of which had not previously been found in the Clyde. The fauna is distinctly littoral. Important information as to the seasonal changes in the fauna was obtained. Medusæ are very scarce in winter, and begin to appear about the middle of March. Most of the forms appear during summer, and begin to die off in September and October. The notes on the pelagic fauna contain an account of a number of miscellaneous animals found in the tow-net at different times of year.—Report on the free-swimming Crustacea found in the Firth of Clyde (1901–2): Dr. T. **Scott.** The summer months were the best and richest for plankton in the Clyde, a characteristic feature of the summer being the vast quantities of diatoms. During the winter months the plankton consists almost entirely of five species of copepods.—On a new method of preparing esters: Dr. W. W. **Taylor.** The water formed by the interaction of the acid and alcohol was removed by the addition of benzene, and distillation of the ternary mixture of alcohol, benzene, and water.—Vanishing aggregates of determinant minors: Prof. W. H. **Metzler.**

PARIS.

Academy of Sciences, June 13.—M. Troost in the chair. —The action of fluorine on the oxygen compounds of nitrogen: Henri **Moissan** and Paul **Lebeau** (see p. 183).—The moving shadows of the total eclipse of the sun of May 12, 1706: G. **Rayet.** Reference to some remarks of De Joly concerning the phenomena of moving shadows observed by him during the total eclipse of the sun, May, 1706.—On a solution of Monge's problem relating to the equation $f(dx_1, dx_2, \ldots dx_n)=0$ with variable coefficients: M. **Bottasso.**—The measurement of the capacity of long submarine cables: M. **Devaux-Charbonnel.** The principle of the method consists of charging the cable and a condenser of known capacity placed in cascade, the capacity of the cable being deduced from the charge taken up by the condenser. The method has several advantages over those in current use, and has been applied with success to the cable recently laid between Brest and Dakar.—Thermoelectric power and the Thomson effect: M. **Ponsot.**—Pyrrhotine, ferromagnetic in the magnetic plane and paramagnetic perpendicularly to that plane: Pierre **Weiss.** The atomic susceptibility of iron in pyrrhotine, measured perpendicularly to the magnetic plane, is very near the atomic susceptibility of iron in paramagnetic bodies.—On the true atomic weight of

nitrogen: G. D. **Hinrichs.** The author gives his reasons for supposing that the atomic weights of the elements can be more accurately determined by calculation than by experiment.—On a mode of formation of acetol by the direct oxidation of acetone: M. **Pastureau.** By the oxidation of acetone in acid solution by hydrogen peroxide, the author shows that in addition to the peroxide already described by Baeyer and Villiger, acetol and pyruvic acid are always formed, the yield of the latter amounting to 75 per cent. of the weight of acetone taken. The application of the reaction to higher ketones would appear to show that in addition to the ketone peroxide, the keto-alcohols and ketonic acids are always formed.—The action of sodium on the esters of the fatty acids: M. **Bouveault** and R. **Locquin.** By the action of sodium on a cooled ethereal solution of ethyl butyrate, the principal product is the keto-alcohol C_3H_7—CO—CH(OH)—C_3H_7, a small quantity of dibutyryl also being obtained.—On some aromatic substitution derivatives of ethylene oxide: MM. **Fourneau** and **Tiffeneau.** The substituted ethylene R—CH=CH_2 is treated with iodine and yellow mercuric oxide, and the iodohydrin thus obtained digested with powdered caustic potash. Details are given of the preparation and properties of phenyl, benzyl, methoxyphenyl, and methylphenyl ethylene oxide.—The action of chloroacetic esters on the halogen magnesium derivatives of aniline: F. **Bodroux.**—On some compounds of azelaic acid: A. **Bouchonnet.** The preparation of the phenyl ester and of thioazelaic acid is described.—On sparteine and its reaction with methyl iodide: Charles **Moureu** and Amand **Valeur.** The authors have isolated from this reaction, besides the iodomethylate already known, an isomer, probably a stereoisomer, distinguished by its higher rotatory power and its solubility in water.—On the pyrolysis of gum lac: A. **Etard** and E. **Wallée.**—On the affinity of artificial colouring matters for conjunctive tissue: M. **Curtis** and P. **Lemoult.** A study of the various stains in use in histological work from the point of view of their permanence.—On the reserve carbohydrates in evergreens: Leclerc **du Sablon.**—On a new banana tree of Madagascar: Pascal **Claverie.** The species described appears to be new, and is named by the author *Musa Perrieri*.—On *Oïdium lactis* and the ripening of cream and cheese: P. **Mazé.** Remarks on a paper on the same subject by M. Arthaud-Berthet.—The ancient coastal lines of the Sahel d'Alger: General **de Lamothe.**—On gladkaïte, a new rock in dunite: L. **Duparc** and F. **Pearce.** Veins of the new mineral are found in the dunite mass on the river Wagran in the N. Ural. It is a silicate of iron, alumina, lime, magnesia, soda, and potash.—On the probable yield of the springs in the basin of the Seine during the second quarter of 1905: F. **Launay** and E. **Maillet.**

NEW SOUTH WALES.

Linnean Society, April 26.—Mr. T. Steel, president, in the chair.—Revisional notes on Australian Carabidæ, part ii., tribe vi., Scaritini: T. G. **Sloane.** Critical observations and tabular lists are offered, and six species are described as new.—The possible relationship between bacteria and the gum of *Hakea saligna*: Dr. R. Greig **Smith.** The conclusions to which this research has led are as follow:—(1) The gum of *Hakea saligna* is neither arabin, metarabin, nor pararabin. The hydrolytic products consist of reducing bodies that yield indefinite osazones, and are probably akin to the furfuroïds of Cross, Bevan, and Smith. It is not pectin, although it approaches this substance in some respects. (2) Of the bacteria occurring in the tissues of the plant, the most probable producer of the gum is one intermediate between *Bact. acaciae* and its variety *Bact. metarabinum*, but as we do not yet know that the host plant can alter a gum once formed by a bacterium, it cannot be said that the gum is produced by this micro-organism.—The origin of natural immunity towards the putrefactive bacteria: Dr. R. Greig **Smith.** The author shows:—(1) That there is a close analogy or identity between the production of bacteriolytic bodies and the digestion of food. (2) That bacteria do traverse the intestinal wall, and that negative experimental results regarding the same are untrustworthy. (3) That natural immunity, especially towards the bacteria that normally inhabit the intestinal tract, is occasioned and maintained by the comparatively few bacteria which, in crossing the intestinal wall and possibly gaining access to the body fluids and organs, stimulate the cells to produce immune bodies. (4) That the agglutination of bacteria may claim a much more active part in the production of immunity than is generally supposed.—The probable bacterial origin of the gum of linseed mucilage: Dr. R. Greig **Smith.** Following is a summary of the research:—(1) The gums of linseed mucilages vary in their chemical reactions, and, therefore, probably vary in their chemical constitution. (2) The products of hydrolysis consist of galactose and reducing substances which yield indefinite osazones that are possibly akin to the furfuroïds of Cross, Bevan, and Smith. (3) The gum bacteria in the tissues of Linum are relatively very numerous, and consist chiefly of races of two species. (4) The chemical reactions of the gums from these are practically identical with the reactions of average linseed gum. (5) The gum of one of the bacteria is hydrolysed to galactose, and of the other to galactose and a reducing substance that yields an indefinite osazone. Both gums contain a large proportion of the furfuroïd substances. (6) The gum formed by bacteria is probably altered by the plant into mucilage and other substances required in the plant economy. (7) A number of so-called species of gum bacteria have probably one common origin; the host plant can alter the nature of the gum product which influences the growth characters.

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THURSDAY, JUNE 29, 1905.

THE FACE OF THE EARTH.

The Face of the Earth (Das Antlitz der Erde). By Prof. Eduard Suess. Translated by Dr. H. B C. Sollas, under the direction of Prof. W. J. Sollas, F.R.S. Vol. i. Pp. xii+604; illustrated. (Oxford: Clarendon Press, 1904.) Price 25s. net.

ENGLISH-SPEAKING geologists will be grateful to Dr. Hertha Sollas and the Clarendon Press for this excellent translation of the first volume of the work which has probably had the deepest influence on geological thought since the publication of Lyell's "Principles." No higher compliment could be offered to such a book than that, twenty years after its publication, it should be worth while to issue a translation without amendment, comment, or other addition than the author's charming letter of introduction. This fact is all the more striking as this volume is mainly a description of the geology of the mountains of the world, and it describes areas of which comparatively little was known in 1884. As Prof. Suess remarks in his introduction, "the reader will meet here and there in the two first volumes with a description already antiquated." This matters the less since we have already an excellent French edition, which has been brought up to date by abundant references to recent literature, and been illustrated by an additional series of maps. The example of the French translators has not been followed, perhaps from the sentimental feeling that as this work is now one of the recognised classics of geology, it should be rendered into English exactly as it came from the hands of the master. This decision will no doubt increase the value of the Oxford edition to future geologists, though it may detract somewhat from its immediate educational usefulness. The absence of the extra maps is an especial drawback to British students, since many of the place-names used are synonyms or transliterations not usually adopted in British atlases. Anything that lessens the educational value of this edition is regrettable, as Suess's work is such magnificent educational material. Prof. Suess's method is to give the detailed evidence upon which he relies; and his readers have the pleasure of working up to the conclusions by the path the author trod. We see his mental process as well as read his results.

This volume opens with a brief statement of some of the geographical homologies which it is the object of the whole work to explain. Prof. Suess dismisses all geometrical plans of the earth, such as Elie de Beaumont's famous *Pentagonal reseau,* as misleading Wills-o'-the-wisp. He fully realises that the first essential to an explanation of the present distribution of oceans and continents is a competent comparison of the facts. As he says, a detailed comparison of observations is necessary before an attempt be made to formulate laws. Suess declines hints as to probabilities from geodesy, and he distrusts speculation as to the hidden parts of the earth. So he studies, with exquisite care, those deeper parts of the crust which have been brought to the surface in the exposed roots of mountains, or which are opened to view by the work of the miner. The two parts of this volume are devoted to a study of the movements in the crust of the earth, and to a description of the mountain system of the world, excluding Australia and some parts of other continents. Prof. Suess concludes from his synthetic study of this wide range of material that the earth's crust is disturbed by movements of two different kinds; firstly, the folding and crumpling of belts of the earth's crust by lateral pressure; and secondly, the foundering of the crust owing to the withdrawal of underground support, consequent on the radial contraction of the globe. Before Suess's time it was usual to regard the distribution of land and water as determined by the uplift as well as the sinking of wide regions. But according to Suess, regional uplifts have never yet been proved, and, excepting perhaps to some local extent, he regards them as impossible. An actual uplift of the surface of the western coast of South America was said to have resulted from the earthquakes of 1822 and 1835. The uplift of the latter was described by Darwin; but Prof. Suess discusses the evidence and dismisses it as wholly inadequate. Any horizontal uplift being, according to Suess, impossible where horizontal marine beds, beaches, or shore-lines occur above sea level, they must be explained by the lowering of the sea, and not by the uprise of the land. Prof. Suess does not hesitate to believe, on the evidence of the plateaus of the Rocky Mountains, that the sea level once stood 30,000 feet higher than at present. If Prof. Suess were to discuss the possibility of regional uplift at the present time, he would have to deal with much weightier evidence than any which he had against him in the year 1884. For the secular uplift of the lake regions of the United States is better established than any of the supposed earthquake elevations of Chili. Moreover, the doctrine of isostasy gives better reason to believe in its possibility. The pendulum work in the Rocky Mountains has rendered it at least possible, that isostasy may account for the horizontal deposits of the high plateaus, which Prof. Suess has described in one of the most brilliant chapters of this volume.

Regional uplifts, however, being dismissed by Prof. Suess, it follows that the main influence in shaping the continents has been the subsidence of wide tracts of the earth's surface beneath sea level. The great ocean basins, and those of the Mediterranean, the Black Sea, and the Caribbean Sea, represent sunken areas of the earth's crust; and foundering to a less depth has caused the rift valleys of Ethiopia, of the Rhine and of Australia, and the basins of Suabia and Franconia. The cause of such subsidences is deep-seated, whereas the crumpling of the long, narrow belts that form the folded mountain chains is due to comparatively superficial action. The two modes of movement may act in the same area at different times. Thus vertical subsidences may destroy the continuity of a folded mountain chain; thus the present form of the Basin Ranges of Utah and Nevada is due to the breaking up, by Cainozoic subsidences, of a series of ranges formed by earlier, post-Jurassic folds. Similarly the outlines of the continents, even when

dependent upon the course of mountain chains, are embayed where the sea has flowed over foundered blocks. The vertical relief of the continents is determined mainly by subsidences, by the resistance of great blocks of strata which remain as plateaus high above the general level of the country, and by the crumpling of bands into mountain chains. The course of such crumpled bands is very sinuous, because they have to adapt themselves to the passive resistance of stronger blocks of the crust; they curve round the margins of the resistant masses, on to the edges of which they may be overthrust. Suess follows, for example, the course of the great Alpine mountain system from its western end in southern Spain, through the Atlas Mountains of Africa, along the the Apennines through Italy, across central Europe as the Alps and Carpathians, and then through the great curve around western Roumania and Servia into the Balkans. Its continuity eastward has been broken by the recent foundering of the Black Sea; but the Alpine system is continued through the Crimea and the Caucasus, and after another gap, caused by the subsidence that formed the southern basin of the Caspian, it is continued across Asia through the Himalaya and the chains of Burma into the islands of Malaysia. Suess explains the sinuous course of this folded band by tracing its dependence upon the unfolded blocks, against which it has been pressed.

The theory of the permanence of oceans and continents inevitably receives slight consideration from Prof. Suess. He does not trouble us with the *a priori* arguments on this question. He simply tells us the contemporary evidence as to the actual age of the continents. Thus he points out that in the Cretaceous period North America was not; but it had come into existence at the beginning of the Laramie period, and has lasted ever since. Similarly the Indian peninsula and Africa south of the Atlas are remnants of the Mesozoic plateau-continent of Gondwanaland, which has been severed into two by the foundering of the Indian Ocean in late Cainozoic times.

Consideration of Prof. Suess's work inevitably suggests a comparison with that of Lyell. Suessism is sometimes regarded as a rival school to Lyellism. But Suess's essential doctrines are a development of Lyell's views rather than being in direct opposition to them. Lyell, for instance, attacked the belief that volcanoes are craters of elevation; but, in the necessary darkness of the days before Sorby's ingenuity had rendered microscopic petrology possible, he retained his belief in an axis of elevation for the mountain chains. Suess has now taught us that the axes of elevation of mountain chains must follow von Buch's craters of elevation of volcanoes. Even in regard to what is sometimes considered as Prof. Suess's arch heresy—his acceptance of great variations in the ocean level—he is opposed to ultra-Lyellists and not to Lyell. The following passage from the "Principles" shows that, with Lyell, Ordnance Datum was not a fetish:—

"This opinion is, however, untenable; for the sinking down of the bed of the ocean is one of the means by which the gradual submersion of the land is prevented. The depth of the sea cannot be increased at any one point without a universal fall of the waters, nor can any partial depositions of sediment occur without the displacement of a quantity of water of equal volume, which will raise the sea, though in an imperceptible degree even to the antipodes. The preservation, therefore, of the dry land may sometimes be effected by the subsidence of part of the earth's crust (that part, namely, which is covered by the ocean), and in like manner an upheaving movement must often tend to destroy land; for if it renders the bed of the sea more shallow, it will displace a certain quantity of the water, and thus tend to submerge low tracts."

One chief difference between Suess and Lyell is that Lyell was naturally inclined to exaggerate the importance of local earth movements. Prof. Suess, with the benefit of a much wider knowledge than was possible to Lyell, and equal intellectual insight, realises that the geological systems are defined, not by independent local movements, but by changes that are world-wide in scope. Suess's views are not essentially opposed to the uniformity, which Lyell established, in opposition to the preceding belief in catastrophes of extraneous origin. Suess and Lyell both teach us that geological changes are due to causes that are still in action. Geographical evolution, like organic evolution, has not been interrupted by external influences or unnatural catastrophes; but it does not necessarily follow that the rate of progress has been uniform. There have been periods of geographical revolution due to a rush of movements, that relieved stresses produced by long periods of slow change. Such disturbances affect the whole world; and it appears probable that the correlation of strata in distant regions will depend on palæontology only for general homotaxis, and on the events of physical geology for the determination of exact synchronism.

A second difference between Lyell and Suess is that the former attached a, perhaps, exaggerated belief to the importance of denudation in modelling the surface of the globe. His own studies lay in lands wherein denudation has been more powerful than recent earth movements. The sub-title of his "Principles"—"the Modern Changes of the Earth and its Inhabitants Considered as Illustrative of Geology"—shows his point of view. He taught men that the common geographical features of Europe and Eastern America were due to the long-continued operation of slow and still active forces; but he did not fully realise that, elsewhere, the major geographical features are the direct expression of recent disturbances of the crust.

As to the cause of the distribution of these disturbances Prof. Suess has not yet given us his full explanation, and in this volume he rightly held such questions premature. But it is now possible, mainly thanks to his work, to trace one controlling factor in the existing plan of the earth—the alternation of periods of spheroidal recovery due to the earth's rotation, with periods of deformation due to the shrinking of the earth's internal mass. This factor promises the clue to the periodicity of geological events, to the general world-wide correspondence in the geological formations, and to the distribution of the folded bands and foundered blocks of the earth's crust.

J. W. G.

THE "N" RAYS.

A Collection of Papers communicated to the Academy of Sciences, with Additional Notes and Instructions for the Construction of Phosphorescent Screens. By Prof. R. Blondlot. Translated by J. Garcin. Pp. xii+83. (London: Longmans, Green and Co., 1905.) Price 3s. 6d. net.

THE *n*-rays, so called because the first announcement of their existence came from Nancy, have attracted the attention of physicists and physiologists all over the world; but the peculiarity about them is that the phenomena said to be produced by these rays when they fall on a slightly fluorescing screen have been observed chiefly in France by Prof. Blondlot and others of his school, while many experienced observers in Germany, America, and England have wholly failed to obtain a satisfactory demonstration even of their existence. The reason is that the so-called proof of their existence depends, not on objective phenomena that can be critically examined, but on a subjective impression on the mind of the experimenter, who sees, or imagines he sees, or imagines he does not see, a slight change in the degree of luminosity of a phosphorescing screen. It is true that, more than once, a photograph has been taken of such a screen supposed to be unaffected and contrasted with a photograph of the same screen when it was supposed to be affected by the rays, with the result that the patch of luminous surface appears to be a little brighter in the latter case than in the former. Even this photographic evidence, however, is unsatisfactory, as a slight difference in the time of exposure or in the method of development would readily account for the apparent contrast.

Yet, in this little book, we have a reprint of Prof. Blondlot's original papers, in which experimental evidence is adduced, with a wonderful appearance of accuracy in detail, of the polarisation of the rays, of their dispersion, of their wave-length, and of other physical phenomena attributed to them. Prof. Blondlot's experiments are well contrived, and they give every appearance of being arrangements by which accurate data should be obtained; but in every case the ultimate test is the subjective one made on the mind of the observer as to whether a spot of slightly phosphorescent surface becomes more luminous or not. The *n*-rays, according to Prof. Blondlot, are a new species of light, light, however, which only affects the retina with the aid of a fluorescent substance. They traverse many metals, black paper, wood, &c. They cannot pass through sheet lead, but they pass readily through aluminium. They influence not only a fluorescent substance, but the spark of an induction coil. They can be reflected from a polished glass surface or from a plate of polished silver. They have a kinship with well known radiations of a large wave-length. They exist in solar rays. Produced from an Auer burner they can be focused by a quartz lens; the lens itself may even become a source of *n*-rays.

Calcium sulphide can store up the rays, while aluminium, wood, dry or wet paper cannot do so. Ordinary light, when it falls on the retina, causes a more luminous sensation when accompanied by *n*-rays. Bits of wood, glass, rubber, &c., emit the rays when compressed. Bodies in molecular strain, like Rupert's drops, hardened steel, &c., emit the rays. An old knife, found in a Gallo-Roman tomb, equally with a new knife, sends out rays. There are other rays also, which must be called n_1-rays, which are emitted from a Nernst lamp. These diminish the glow of an induction spark. Ethylic ether, "when brought to a state of forced extension," emits the n_1-rays, &c.

To see all these wonderful phenomena the eye must be not only kept in the dark for a considerable time, but it must be specially trained. A. Broca states that in his own case it required practice for six weeks before he could see the effect of the rays. The eye must be adapted not only to darkness, but to very feeble light. The mind must be free, so as to concentrate itself on the observation to be made. These seem to be admirable arrangements for obtaining an illusive subjective impression! It is said that MM. d'Arsonval and Mascart have also observed some of the phenomena. Many other French observers, with less weighty names, have also been cited as witnesses. The general body of men of science are doubtful, as they cannot receive evidence of such a strangely subjective character, while not a few, and the writer places himself in this category, are of opinion that while they do not for a moment reflect on the *bona fides* of the French observers, they hold that these observers have been the subjects either of an illusion of the senses or a delusion of the mind.

JOHN G. MCKENDRICK.

THE SCIENCE OF EDUCATION.

School Teaching and School Reform. By Sir Oliver Lodge. Pp. viii+171. (London: Williams and Norgate, 1905.) Price 3s.

THE science of education is as yet rudimentary and ill-defined. So little has it developed, indeed, that many schoolmasters deny its existence. An art of education they recognise, and that they claim to practise. Teachers, it is urged, are born, not made, and professional training is useless. Yet it is the possibility of the future existence of a complete science of education which is the inspiring belief of the best modern educators. These teachers are now approaching the problems of the class-room and the difficulties of school organisation as subjects for investigation and experiment by scientific methods, and there is every reason for hopefulness in the results which have been obtained in recent years.

The formulation of the fundamental principles of a complete science of education will probably be the work of some great educationist as yet unborn, who will be able from the educational material at his command to extract the essentials and to weave them into living generalisations round which the science will crystallise into an orderly and harmonious whole To the elucidation of such a science many workers

must contribute, and to ensure success men both familiar with science and aware of the difficulties with which teachers have to cope must lend their aid. It is for this reason we welcome these lectures by Sir Oliver Lodge, representing as they do the experience gained by a man of science in many departments of work.

The lectures range over a great variety of topics, and the subjects are presented with but little arrangement. But informal and disconnected though they are, the chapters will cause earnest teachers to reconsider their methods, and strenuously to strive after the improvements adumbrated. Sir Oliver Lodge rightly affirms that the two most important questions for educators to-day are, "What subjects should be selected for teaching?" and "How should they be taught?" But these are precisely the problems teachers have had to face since the Renascence, and we seem little nearer solutions than were the educators of three hundred years ago. A complete answer to the questions propounded will remain impossible until psychology has demonstrated the precise stages in the growth of the immature human intelligence and determined what instruction will assist best each step of such development. For psychology to accomplish this task many carefully planned experiments, carried out by practical teachers imbued with the scientific spirit, are necessary, and the results arrived at must be chronicled and subjected to the most searching criticism.

Mere expressions of opinion will not greatly assist the coming of the new science. What is wanted is investigation. If the man of science will cooperate with the practical schoolmaster, there is no reason why it should not be possible to answer the two vital questions re-stated by Sir Oliver Lodge. But it is imperative that we formulate, after exhaustive discussion, clearly defined problems to be put to the test of experience in schools, and that when we have agreed upon the results we act upon them. It is in this direction that the most fruitful work for education is to be done.

It is unnecessary to summarise the contents of the lectures before us. It is sufficient to say they touch upon the whole field of education. Sir Oliver Lodge is always suggestive, and his *obiter dicta* may be commended to the attention of men of science and school teachers alike. Of all the subjects calling for scientific study and research, the education of the young is the most important. This deserves pre-eminently to occupy the serious attention of all who desire the well being of the human race. A. T. S.

BRITISH BIRDS.

British Bird Life. By W. Percival Westell. Pp. xxxv+338. (London: T. Fisher Unwin, 1905.) Price 5*s*.

THE wearisome procession of books on British birds still drags on—a long train of volumes, all of necessity telling the same tale, and for the most part badly. The laboured apologies which most of these weaklings bring with them show, indeed, that their respective parents realise how slender is the chance of their finding favour even at the hands of a public proverbially long-suffering. Yet still they come.

The present volume endeavours to justify its existence on the plea that "there is need for a work *entirely devoted to those species which nest amongst us year by year* . . ."; and yet a number of species are included in this book which, on the author's own admission, do *not* breed with us year by year. Such are the Canada goose, little owl, golden oriole, hoopoe, and fire-crested wren. To these may be added the white-tailed eagle, spotted crake, roseate tern, and quail! On the other hand, there is reason to believe that the snow-bunting—included in this book—nests annually in Scotland, yet this fact is not even hinted at.

No more trustworthy are the author's statements as to "where our summer migrants spend the winter."

While we heartily agree with much that Mr. Westell has to say on the subject of the relentless persecution which of late years has been meted out to the birds of prey, we must protest against the hysterical notions of justice which he expresses in regard to a case wherein four men were fined thirty shillings apiece for taking a nest of young peregrines "A good dose of the cat," he contends, "or imprisonment without the option of a fine, would probably have had a better effect than a fine of a few shillings"!

As touching this same species, the author gravely assures us that falconry is "a very costly hobby, even the most ordinary Hawks used for falconry costing as much as 10*l*. apiece. They require the most careful attention, and it is difficult to get men qualified to take charge of them under a salary of, say 200*l*. a year."

The photograph purporting to be that of a sparrow hawk is really a picture of a kestrel.

At times Mr. Westell becomes ecstatic, and, blinded by the intensity of his emotions, rushes onwards regardless of obstacles—even of the rules of grammar—as witness the peroration which forms the concluding paragraph of his book:—

"For the good most birds do, for their cheery voices and winning ways, their charming forms and delicate colouring, their beautifully woven nests and exquisite eggs, their fairy-like flight, and other interesting characteristics, I appeal to my readers to study them with a bloodless intention, and to endeavour to learn practical lessons from their industry and devotion to their young; to study them as animate beings, and not as gazed upon as wretched caricatures of bird-life too often found in Museums and collections, and to endeavour to be of some service in specially inculcating and fostering within young and growing children an intelligent love for the bird life of our country"!!

This book is profusely illustrated, partly by photographs, some of which are very pleasing, and partly by "original" drawings, all of which are bad.

W. P. P.

OUR BOOK SHELF.

Riding and Driving. (American Sportsman's Library.) By E. L. Anderson and P. Collier. Pp. xiii+441; illustrated. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1905.) Price 8s. 6d. net.

IN almost all books on subjects connected with animals there is a growing tendency at the present day to introduce something concerning the natural history of the species under consideration. Too often in this country such remarks betray an insufficient knowledge of zoological science on the part of the writer, but this failing is seldom noticeable in American works. In the present volume, truth to say, there is some matter for criticism in Mr. Collier's remarks on the origin of the horse on p. 169, more especially in regard to the sense given to that much abused word "prehistoric." On the other hand, the author furnishes some very interesting information with regard to the early history of the European horse in America. In the first place he refuses to credit the theory that the horses seen by Cabot in La Plata in 1530 were indigenous. Secondly, he shows that the horses which have run wild in Mexico and South America are the descendants of Spanish barbs, and therefore of the same blood as the English thoroughbred. This is very important in view of a fact recently communicated to the present writer by Mr. Yearsley, the well known surgeon, namely, that an Argentine horse living some years ago had a functional "larmier," or tear-gland, on each side of the face.

To review the work before us from its own special point of view would obviously be out of place in this Journal, and it must therefore suffice to say that it appears, so far as we are capable of judging, to maintain the high standard of excellence set in the earlier volumes of the same series. Riding falls to the lot of the first-named of the two authors, while Mr. Collier is responsible for the section on driving. The numerous reproductions from photographs are almost life-like in their sharpness and definition, although it must be confessed that some of them do not convey by any means a pleasing idea of the manners and disposition of the American saddle-horse.

R. L.

Der Oeschinensee im Berner Oberland. By Max Groll. Pp. vi+78; illustrated. (Bern: Haller'sche Buchdruckerei, 1904.)

THIS pamphlet, an extract from the nineteenth volume of the Berne Geographical Society, is the result of a careful study of the Oeschinensee at intervals from 1901 to 1903. Nestling at the foot of the limestone precipices of the Blumlisalp group, about 5200 feet above sea-level, and reflecting like a mirror the snows of their highest peaks, its romantic beauty makes it a favourite resort of visitors to Kandersteg, on the northern side of the Gemmi Pass.

Herr Max Groll's memoir is a valuable contribution to physical geography. After some preliminary information about the position and surroundings of the lake, which lies roughly along the strike of Eocene and Cretaceous limestones, and about other matters of a topographical character, he describes its banks and basin, its dimensions and contents, its variations in level, the transparency, colour, and temperature of its waters, the amount of mud yearly deposited, and adds a note on the literature.

Of these topics, the form of its basin is, perhaps, of most general interest, and of that Herr Groll gives an excellent map and sections plotted from numerous soundings. Its dimensions, of course, vary somewhat with the season, the greatest length and breadth (in summer) being 1750 and 950 metres, when its greatest depth is 56.6 metres; in winter it is about 200 metres less one way and 100 metres the other, and shallower by 15 metres. Under the former conditions its cubical content is estimated to be forty million metres. Its bed deepens at first rather rapidly, a circular diagram of the progressive depth reminding us of an ordinary dinner plate. The ring in which the drop is from 0 to 50 metres is barely an inch wide; the radius of the remainder, which nowhere attains 57 metres, is almost an inch and a half, or, on a rough estimate, about half the lake bed is not less than 50 metres deep. The shallowing is rather more gentle on the western than on the eastern or Blumlisalp side. Near the middle part of this, the 50-metre contour comes rather near the cliffs, those less than 30 metres being closely crowded. This would be yet more conspicuous but for a fan of débris at the south-east angle. The lake, in fact, lies in a kind of corrie at the head of a mountain glen, and it is held up by a natural dam which has been formed by bergfalls from the rocky spurs about a mile below the cliffs at its head. Thus its history is to a considerable extent parallel with that of the Lago d'Alleghe, near Caprile, in the Dolomites.

Manual of the Trees of North America (exclusive of Mexico). By C. S. Sargent. Pp. xxiii+826. (Boston and New York: Houghton, Mifflin and Co., 1905.) Price 6 dollars.

THE manual under notice embodies the most recent, exhaustive, and detailed account of the trees of North America (exclusive of Mexico). It cannot fail to be of the greatest value to students of botany and forestry, as it brings into available form all the information concerning the trees of North America which has been gathered at the Arnold Arboretum during the last thirty years. As the author points out in the preface, there is probably no other region of equal extent where the indigenous trees are so well known as those of North America, but in spite of this fact much investigation yet remains to be done as regards their sylvicultural requirements, and also the diseases to which they may be liable.

The object of this volume is to stimulate further inquiry into the cultivation requirements and diseases of forest trees. The classification adopted is that of Engler and Prantl's "Die naturlichen Pflanzenfamilien." At the beginning of the book a synopsis of the families of the plants described is given. This is followed by a very useful analytical key to the families based on the arrangement and character of the leaves, which will enable the student readily to determine the family to which any North American tree belongs. In the text a full description of each family is given, and also a conspectus of the genera based on their more salient and easily made out contrasting differences. Under each genus a similar conspectus of the species is given by which the exact name of the tree may be finally determined.

The frontispiece consists of a map of North America showing the eight principal regions of arborescent vegetation, each of which is indicated by a letter, and in the conspectus above referred to a letter occurs after the name of each species, thus indicating the region in which the tree grows. This is a further aid in determining any given species provided the region from which it comes is already known.

A valuable feature of the book is the numerous illustrations, which number between six and seven hundred, from drawings by Mr. Faxon.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Number of Strokes of the Brush in a Picture.

THE number of strokes of the paint brush that go to making a picture is of some scientific interest, so I venture to record two personal experiences. Some years ago I was painted by Graef, a well known German artist, when, finding it very tedious to sit doing nothing, I amused myself by counting the number of strokes per minute that he bestowed on the portrait. He was methodical, and it was easy to calculate their average number, and as I knew only too well the hours, and therefore the number of minutes, I sat to him, the product of the two numbers gave what I wanted to learn. It was 20,000. A year and a half ago I was again painted by the late lamented artist Charles Furse, whose method was totally different from that of Graef. He looked hard at me, mixing his colours the while, then, dashing at the portrait, made his dabs so fast that I had to estimate rather than count them. Proceeding as before, the result, to my great surprise, was the same, 20,000. Large as this number is, it is less than the number of stitches in an ordinary pair of knitted socks. In mine there are 100 rows to each 7 inches of length, and 102 stitches in each row at the widest part. Two such cylinders, each 7 inches long, would require 20,000 stitches, so the socks, though they are only approximately cylinders, but much more than 7 inches long, would require more than that number.

The following point impressed me strongly. Graef had a humorous phrase for the very last stage of his portrait, which was "painting the buttons." Thus, he said, "in five days' time I shall come to the buttons." Four days passed, and the hours and minutes of the last day, when he suddenly and joyfully exclaimed, "I am come to the buttons." I watched at first with amused surprise, followed by an admiration not far from awe. He poised his brush for a moment, made three rapid twists with it, and three well painted buttons were thereby created. The rule of three seemed to show that if so much could be done with three strokes, what an enormous amount of skilled work must go to the painting of a portrait which required 20,000 of them. At the same time, it made me wonder whether painters had mastered the art of getting the maximum result from their labour. I make this remark as a confessed Philistine. Anyhow, I hope that future sitters will beguile their tedium in the same way that I did, and tell the results. F. G.

The Hydrometer as a Seismometer.

A SHORT time ago (NATURE, May 25) I directed attention to a misconception which seemed to prevail among seismologists as to the behaviour of a spirit-level. It may perhaps be useful to point out another fallacy, also of an elementary hydromechanical nature, involved in some of the unsuccessful attempts to record vertical motion.

It was first proposed by Dr. Wagener, we read,[1] to record vertical disturbance by means of a floating buoy free to rise and fall in a vessel of water. The buoy was to provide a steady point when the vessel suffered a vertical disturbance. The device was improved, we are told, by Prof. Thomas Gray, who gave the buoy the form of a hydrometer with only a slender stem projecting above the surface of the water. Prof. Milne experimented with both forms; but even with the hydrometer form, adjusted to a state of the most sluggish stability, several earthquakes left no record of vertical motion. The instrument was abandoned as not sufficiently powerful to be self-registering.

But the theory involved in these attempts is entirely fallacious. Any body, be it buoy or hydrometer, floating in liquid, suffers no displacement whatever relatively to the liquid when the containing vessel is moved vertically. The whole moves as one rigid system. More generally, it may be claimed that any system which is in statical equilibrium, and which would remain undisturbed despite a change in the value of gravity, may suffer a vertical displacement of its supports without any relative disturbance of its parts. The whole of such a system moves as if rigid when displaced vertically. Of such a kind is the hydrometer floating in the vessel filled with liquid; of the same kind, also, is a common balance with equal weights in the two scale-pans. These two systems present a true dynamical analogy, and are equally useless for detecting vertical disturbance. A spring supporting a load, on the other hand, or any form of apparatus the potential energy of which is partly elastic, is not of this class, and is available as a seismometer for vertical motion. It would seem as though a false analogy between the hydrometer and the spring balance had led to the fallacy in question.

The spirit-level (if my previous contention is conceded) is sensitive alike to each of two kinds of disturbance between which it was expected to discriminate. The hydrometer, on the other hand, is insensitive to the very disturbance which it was designed to record. The freezing of the water, indeed (contemplated as an inconvenient contingency with the proposed instrument), would, very precisely, make no difference at all in its behaviour. The instrument has, it is true, been long superseded; but the false principle involved remains as a source of grave confusion for the unwary reader of seismological writings.

It may be remarked that violent earthquakes have been known to damage the rigging of ships in a neighbouring harbour, and to jerk guns from the decks, without any visible movement of the water. Assuming the correctness of the view now urged, a sudden alteration of sea-level would completely account for this. The ship is not in any way spring-borne for such a displacement, but may be subjected to a vertical impulse of any degree of severity.

It should be added, also, that a severe shock of earthquake is credited[1] with having disturbed a hydrometer instrument to the extent of 1·1 mm. If the onus of explanation rests with me, I can only suggest that the effect (if really caused by vertical motion at all) may perhaps have been due to the elasticity of the walls of the containing vessel or of the hydrometer. G. T. BENNETT.

Emmanuel College, Cambridge.

[1] Milne, "Earthquakes," p. 33; Milne, "Seismology," p. 65; *Trans. Seismological Soc. of Japan*, vol. i., p. 70, vol. iii., p. 54.

[1] *Trans. Seismological Soc. of Japan*, vol. iii., p. 55.

The Pressure of Radiation on a Clear Glass Vane.

IN an article on "The Elimination of Gas Action in Experiments on Light Pressure," read before the American Physical Society in December, 1904, and published in the *Physical Review*, May, the writer made the following statement:—"A thin vane of clear glass, accurately vertical and mounted radially, may be used to advantage to demonstrate light pressure. If the light has been filtered through several thicknesses of glass there will be but little absorption by the thin vane and its two surfaces will be warmed nearly equally. Consequently the radiometric effect will be small. The reflection of the radiation at the two surfaces will make a difference of about 16 per cent. between the energy in front of and behind the vane. Hence the light pressure will be about one-sixth of that due to the same light beam falling upon a black surface. The throws for such a vane had only about a ten per cent. variation in a range of air pressures from about 10 mm. to 200 mm. of mercury."

Although a large number of observations had been taken on both clear glass and silvered glass vanes, the data were not published at that time. It was then felt that the elimination of gas action was the important point, and the final statement in the paragraph quoted, that the throws for such a vane had only a 10 per cent. variation in a range of air pressures from about 10 mm. to 200 mm. of mercury, was considered sufficient experimental evidence that gas action had been eliminated.

Since this paper appeared, the writer has learned that there is a difference of views among mathematical physicists concerning the pressure of radiation on a non-absorbing medium. On this account he has gathered

together the original data in order to compare the light pressure upon a vane of clear glass with that upon a silvered surface.

The experiment may be here recalled. A torsion balance carrying a thin vertical glass vane, $14 \times 10 \times 0 \cdot 1$ mm., silvered on one side, was suspended in a bell jar, and the air was pumped out until the pressure was about 40 mm. of mercury. A beam of light was thrown upon this vane at a definite distance from the rotation axis, and by turns on each side of it. The deflections were read by a telescope and scale. A Nernst lamp was used as a source, the intensity being given by a precision wattmeter. The balance was then turned through 180° by the rotation of the external control magnet, and readings were again taken. The mean was proportional to the pressure of the incident and reflected beam. The mean reflection coefficient of air-silver and air-glass-silver for the radiation used has been found to be 85 per cent. The pressure, according to Maxwell's theory, should therefore be 1·85 times that due to the incident beam. The throw obtained (containing certainly less than 1 per cent. of gas action) was 22·8 divisions. Hence the pressure of the standard beam upon a black surface would be $22 \cdot 8 \div 1 \cdot 85$ or 12·4.

The balance was then taken from the bell jar, the silver removed from the vane, and the glass surface cleaned. The balance was then replaced, and the air pumped out as before. The deflections were small, only about 2 mm., and therefore could not be read to a greater accuracy than 5 per cent. The throw obtained for standard lamp was 2·1 divisions (the mean of forty observations at four different air pressures).

The normal reflection coefficient of glass ($\mu = 1 \cdot 52$) for this kind of radiation is 4·1 per cent. The amount reflected from the two surfaces is approximately 8·2 per cent. Hence the energy per unit volume in front of the glass is about 1·082 times that of the incident beam, and that behind the vane (since the absorption is negligible) is 0·918 times that of the incident beam. The former quantity is greater than the latter by 16·4 per cent. of the energy of the incident beam. Assuming that the pressures on the front and back surfaces of the glass are proportional to the energies per unit volume, the pressure of the standard beam upon a black surface would be $2 \cdot 1 \div 0 \cdot 164$ or 12·7. The agreement between this result and the similar result obtained from the silvered surface shows that light passing through a plate of glass exerts pressures upon the surfaces equal to the difference between the energies per unit volume in front of and behind these surfaces.

GORDON F. HULL.

Dartmouth College, Hanover, N.H., U.S.A.

The Habits of Testacella.

UNTIL reading Mr. Latter's letter in this week's NATURE I was unaware that it was not a matter of common knowledge that Testacella appears on the surface during heavy rains. My garden is liable to be flooded, as also, unhappily, is much of this neighbourhood, in spring and late autumn. After the water has stood for a few days the ground is covered by hundreds of these slugs, which leave their burrows and try to find dry quarters. They can survive, however, a week's immersion. In June, 1903, when much of the Thames valley was flooded, I collected a number of these slugs for various malacological friends. In normal circumstances they live at such a depth as never to be unearthed during garden operations.

Eton College, Windsor. M. D. HILL.

NATURE AND MAN.

PROF. LANKESTER in his Romanes lecture began by a statement of the theory of evolution, directing attention to unwarranted inferences commonly drawn by clever writers unacquainted with the study of nature. He described how the change in the character of the struggle for existence, possibly in the Lower Miocene period, which favoured an increase in the size of the brain in the great mammals and the horse, probably became most important in the development of man. The progress of man cut him off from the general operation of the law of natural selection as it had worked until he appeared, and he acquired knowledge, reason, self-consciousness, and will, so that "survival of the fittest," when applied to man, came to have a meaning quite different from what it had when applied to other creatures. Thus man can control nature, and the "nature-searchers," the founders of the Royal Society and their followers, have placed boundless power in the hands of mankind, and enabled man to arrive at spiritual emancipation and freedom of thought. But the leaders of human activity at present still attach little or no importance to the study of nature. They ignore the penalties that rebellious man must pay if he fails to continue his study and acquire greater and greater control of nature.

Prof. Lankester did not dwell upon the possible material loss to our Empire which may result from neglect of natural science; he looks at the matter as a citizen of the world, as a man who sees that within some time, it may be only 100 years, it may be 500 years, man must solve many new problems if he is to continue his progress and avert a return to nature's terrible method of selecting the fittest. It seems to us that this aspect of the question has never been fully dealt with before. Throughout Huxley's later writings the certainty of a return to nature's method is always to be felt. Prof. Lankester has faith in man's power to solve those problems that seem now to be insoluble, and surely he is right.

The dangerous delay now so evident is due to the want of nature knowledge in the general population, so that the responsible administrators of Government are suffered to remain ignorant of their duties. Prof. Lankester shows that it is peculiarly in the power of such universities as Oxford and Cambridge, which are greatly free from Government control, to establish a quite different state of things from that which now obtains in England. He says:—"The world has seen with admiration and astonishment the entire people of Japan follow the example of its governing class in the almost sudden adoption of the knowledge and control of Nature as the purpose of national education and the guide of State administration. It is possible that in a less rapid and startling manner our old Universities may, at no distant date, influence the intellectual life of the more fortunate of our fellow citizens, and consequently of the entire community." Considering Oxford more particularly, and speaking for others as well as himself, he says:—"The University of Oxford by its present action in regard to the choice and direction of subjects of study is exercising an injurious influence upon the education of the country, and especially upon the education of those who will hereafter occupy positions of influence, and will largely determine both the action of the State and the education and opinions of those who will in turn succeed them." As to Greek and Latin studies, he says:—"We have come to the conclusion that this form of education is a mistaken and injurious one. We desire to make the chief subject of education both in school and in college a knowledge of Nature as set forth in the sciences which are spoken of as physics, chemistry, geology and biology. We think that all education should consist in the first place of this kind of knowledge, on account of its commanding importance both to the individual and to the community. We think that every man of even a moderate amount of education should have acquired a sufficient knowledge of these subjects to enable him at any rate to appreciate their value, and to take an interest in their progress and application to human life." He points out that it is only in the

last hundred years that the dogma of compulsory Greek and the value of what is now called a classical education has been promulgated. Previously, Latin was learnt because all the results of the studies of natural philosophers were in that language.

It is evident that Prof. Lankester includes in his study of nature the study of intellectual and emotional man through history, biography, novels, and poetry, but we think that he made a tactical mistake when he neglected to state this clearly. It seems to us that besides the study of nature, the most important thing in a child's education is to make him fond of reading in his own language, for this leads to a future power to make use of books and self-education for the rest of his life. When Prof. Lankester doubts the value of the study of history he is evidently doubting the value of that study as carried on at Oxford, and surely no person who has read the scathing criticism of Prof. Firth will disagree with him. When he speaks of a reform being possible, it may be that he is taking into account a movement of which but little is known outside Oxford itself, the growing indignation of the average undergraduate at being made to pay extravagant sums of money for tuition which is mischievous.

The readers of NATURE are well acquainted with the views put forward in this address. Huxley and many others, dwelling, perhaps, more upon material loss to our Empire, have published them over and over again, but we do not think that anybody has ever presented them with so much grace of style or so much of an endeavour to secure the goodwill of his audience as Prof. Lankester. But, alas! we fear that this fine address will share the fate of many others!

When, thirty-three years ago, Japan began her new career, there were a few people like Ito clever enough to see and say that the study of ancient classics alone, to the neglect of the study of nature, meant ruin to the country; but such ideas would never have been adopted had not Japan been in deadly peril. All the nations of Europe bullied and insulted her, and it was only their mutual jealousies which saved her from complete subjugation. In the presence of that peril the pedants held their peace, and everybody saw the necessity for an immediate, radical reform. In time nature was studied by every child in Japan, and in consequence scientific methods of thinking and acting have permeated the whole nation. All ancient and modern European literature is open to the Japanese who knows English, and English is the one language other than Japanese which every cultured man must know. In the matter of self-protection, anyone can see the result. Because the Japanese have studied nature their scientific officers and men have marched or sailed to victory in every engagement; their statesmen will do exactly what is best for Japan in the negotiations for peace; their country will quietly take its place as one of the first-class Powers of the world, and every person who knows anything about Japan is quite sure that ambitious, wrong-headed schemes of conquest are altogether impossible to the scientific minds of the Japanese.

If Japan had not been in great danger we know that she would not have taken to nature-study, and some of us think that it may need a state of danger in England to produce the necessary desire for reform. The South African muddle was worried through, and almost everybody seems to think that all such muddles may also be worried through, but some of us think that we may not always be so lucky. Danger is close enough even now, and we can only hope that if it becomes great it may grow slowly enough to let us learn something from the object lesson which is being given us day by day in the news from Russia and the Far East.

Fain would we hope that Oxford will pay attention to what has been said by one whom some of us regard as her cleverest son; but, alas! we have no such hope. Oh, Shade of Clough, how can we help saying that "the struggle nought availeth" when your own best admirers seem unable to think for themselves?

JOHN PERRY.

A LIFE'S WORK IN THE THEORY OF EVOLUTION.[1]

IN this elaborate and carefully written treatise the veteran biologist of Freiburg has brought together and presented in connected form the fruit of his life-long investigation of the principles and methods of organic evolution. It would be an easy matter to show—indeed, the author admits as much with perfect candour—that his present standpoint differs in many important respects from that adopted by him at former periods of his career. The fact that Weismann has more than once shifted his ground has often been brought against him as a kind of reproach—we think with scant justice; for in a subject like the present, where new facts come crowding upon us almost daily, it is unreasonable to expect that a far-reaching theory should at once attain finality. If the author of such a theory should be willing to recognise that some parts of it become untenable and others require modification in the light of fresh discoveries, this should be reckoned to his credit rather than otherwise. The practice of putting forward ill-considered and hasty views deserves severe condemnation; but it is characteristic of our author that even his boldest speculations rest for the most part on a basis of observed fact, and that he has always honestly striven to render his theory consistent both with itself and also with the new facts that have from time to time come under the observation of other investigators. Moreover, his plan of, so to speak, taking the scientific world into his confidence, and enabling his colleagues to follow the workings of his own mind, has not only added greatly to the interest of his contribution to the biological thought of our time, but has acted also as a powerful stimulus to fellow-workers in the same field. So much may fairly be said, whether his final conclusions meet with general acceptance or the reverse.

The first eleven chapters of the present book traverse familiar ground. Starting with a brief historical account of evolutionary theory up to and including the work of Darwin and Wallace, they proceed to a more detailed discussion of such branches of the subject as the coloration of animals, mimicry, instinct, symbiosis, protective adaptations in plants, the origin of flowers, and sexual selection. These are well-worn topics, but their treatment is interesting and by no means trite. Next comes a discussion of Roux's suggestion of the "Kampf der Theile" which strikes us as somewhat of an excrescence on the general structure of the treatise. The existence of a metabolic response to functional stimulus is undeniable, but we do not think that either Roux or Weismann has plumbed the matter to the bottom, and the latter author's use of the term "selection" in this connection appears to involve some overstrain of language.

[1] "Vorträge über Deszendenztheorie gehalten an der Universität zu Freiburg im Breisgau." By Prof. August Weismann. Second revised edition. 2 vols. Pp. xii + 340; vi + 344. (Jena: Gustav Fischer, 1904.) Price 10 marks.

"The Evolution Theory." By Prof. August Weismann. Translated with the author's co-operation by Prof. J. Arthur Thomson and Margaret R. Thomson. 2 vols. Pp. xvi + 416; iv + 405; illustrated. (London: Edward Arnold, 1904.) Price 32s. net

Chapters on reproduction and the process of fertilisation in both unicellular and multicellular organisms lead us on to a copious exposition of the author's theory of the germ-plasm and its constitution, with the building up of the assumed ultimate vital units or "biophors" into the successive complexes of "determinants," "ids," and "idants." After a discussion of the facts brought to light by the labours of the "Entwicklungsmechanik" school, and a fairly full notice of recent work on regeneration in its relation to the germ-plasm hypothesis, we come to what is in many respects the strongest part of the book, the refutation, namely, of the Lamarckian view of the transmissibility of functional modifications. Here Weismann has always been at his best, and to him undoubtedly belongs the credit of having awakened and sustained so fresh and vigorous a body of opinion in reference to this point as virtually to have created one of the most important epochs in the history of evolutionary doctrine. The two next chapters deal with the author's hypothesis of "germinal selection," as to which it may be sufficient to remark that, however ingenious and interesting the theory may be as an attempt to explain the chief phenomena of variation, it is as yet far from having reached the stage of verification. In the succeeding chapters, which deal with inbreeding, parthenogenesis, and reproduction, both sexual and asexual, it is interesting to observe that Weismann has considerably modified his standpoint with reference to amphimixis, his present view approximating in some degree to that advanced several years ago by Haycraft. This section is preceded by a discussion of the "biogenetic law" of Haeckel, and is followed up by chapters on the influence of the environment and of isolation in the formation of the specific type, together with the various causes of extinction.

The book concludes with some theoretical considerations on the subject of spontaneous generation, and a final vindication of the principle of selection, the dominance of which principle over all the categories of vital units may be taken as the key-note of the entire treatise.

It will be seen that the ground covered by this work is very extensive. Though most of the topics dealt with are considered by the author chiefly or solely with an eye to his theory, his treatment never lacks interest, and the result is worthy of his high reputation. There are some points as to which we should have welcomed a more thorough discussion, and others on which we confess to remaining unconvinced for reasons *quas nunc perscribere longum est*; but it would be ungrateful not to acknowledge to the full the immense services rendered to biological science by the stimulating labours in the domain both of theory and practice of which this book is a monument.

The illustrations are for the most part excellent. Of the two here reproduced, the first serves to illustrate the basis of one of the chief arguments brought forward by Weismann, as also by Strasburger and O. Hertwig, in favour of regarding the nuclear chromatin as the true hereditary substance, viz. the numerical equality of the chromosomes and the disparity in amount of the cell-protoplasm in the generative products of the two sexes. The second (from Fischer) supplies evidence of the possibility of certain external conditions, in this case temperature, influencing the germ-plasm even while contained within the body of the parent.

We have little space left for detailed criticism, but must point out that by some unaccountable oversight the letterpress of plates i. and ii. contains several serious errors—patent at once to the trained entomologist, but calculated to mislead the general reader. These mistakes appear uncorrected in the English translation, where also, as if to make confusion worse confounded, "die folgende Art" (plate ii., Fig. 20) is rendered "the *foregoing* species." Fortunately, however, the lapses in question are not of

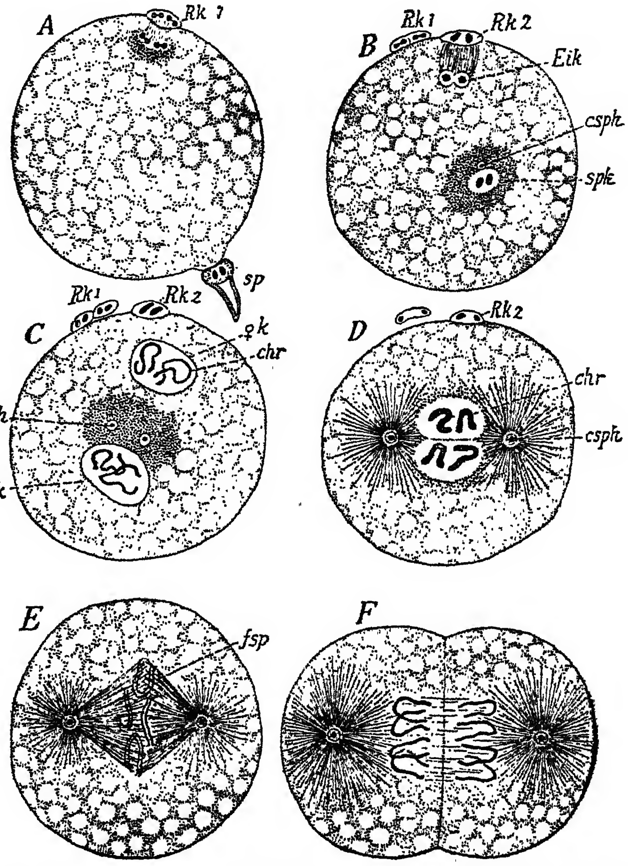

FIG. 1.—Process of fertilisation in *Ascaris megalocephala*. *Rk* 1, *Rk* 2, first and second polar body; *sp*, spermatozoon with two chromosomes, a protrusion of the egg-protoplasm is meeting it; *Eik*, reduced nucleus of the ovum; *spk*, nucleus of spermatozoon; ♂ *k*, ♀ *k*, sperm nucleus and ovum nucleus, each with two chromosomes (*chr*); only the male nucleus has a centrosphere (*csph*), which in *C* has already divided into two; *fsp*, segmentation spindle. From Weismann's "Evolution Theory." Translated by Prof. and Mrs. Thomson.

a nature to impair the value of the argument which the figures are meant to illustrate.

Other slips in the translation are plainly due to the fact that the translators are unfamiliar with portions of the subject-matter, as in vol. ii., p. 348, where the point of the argument is blunted by the rendering of "Nachtfalter" as "butterfly"; such imperfections, though they should be remedied in a new edition, are of little real importance. More serious is a mistranslation, or perhaps a misprint (vol. i., p. 290) by which the words of the original, "in welchem die eigentliche Chromatinsubstanz nur in vielfacher Zertheilung enthalten ist," are perverted into a statement which is almost grotesquely incorrect.

Again, on p. 304 of the same volume, an entirely wrong meaning is given to a sentence by the failure of the translators to make it clear that "wenn es nothwendig wäre" must refer, not to "fertilisation," but to the "limitation of polar divisions." On p. 136 (vol. ii.) the sense of the original is obscured by the inadequate rendering of "dann" as the enclitic "then." *Chaerocampa* (for *Choerocampa*) is found in the original; the translators, however, are responsible for "Cœnogenesis."

But in spite of these and other blemishes of a like nature, the translators are to be congratulated on having performed their difficult task with skill and success, the result being a work which, in its English

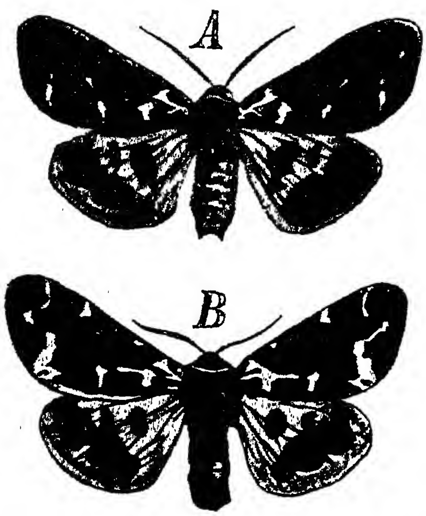

Fig. 2.—*A*, an aberration of *Arctia caja*, produced by low temperature. *B*, the member of its progeny most divergent from the normal. *B*, though reared at the ordinary temperature, is aberrant in the same direction as its parent. After E. Fischer. From Weismann's "Evolution Theory." Translated by Prof. and Mrs. Thomson.

no less than in its German dress, will be read with extreme interest and with the greatest sympathy and respect for its indefatigable author. F. A. D.

DR. WILLIAM THOMAS BLANFORD, F.R.S.

The tidings of Dr. Blanford's death will be received with sorrow among men of science all over the world. His many-sided accomplishments had given him a notable place among geologists, geographers, palæontologists, and zoologists, and his gentle, kindly, unassuming nature had gained him an abiding place in the affectionate regard of all who came to be associated with him. Born on October 7, 1832, in London, he early developed a taste for scientific pursuits, and was accordingly sent to the Royal School of Mines, Jermyn Street, where he distinguished himself as a student, under De la Beche, Playfair, Edward Forbes, Ramsay, Smyth, and Percy. From London he passed to the famous mining academy at Freiberg. Having thus obtained an excellent training, he was, in 1855, appointed to the Geological Survey of India under its founder, Thomas Oldham. For some twenty-seven years he continued to devote his energies to Indian geology, making wide acquaintance with the rocks and scenery of the great Dependency, and enriching the publications of the Survey with maps and descriptive memoirs. Had he chosen to remain longer in the service, he would soon have been placed at its head; but in 1882 he resolved to retire on the pension which he had well earned, and to establish himself in London. Among the great services which he rendered to science during his stay in India, perhaps the most important was the preparation, in concert with his colleague, H. B. Medlicott, of a "Manual of the Geology of India." This invaluable treatise gave for the first time a succinct general view of the geological structure and history of the whole country. It has taken its place as one of the classic text-books of the science.

While attached to the Indian Survey, Dr. Blanford's proved ability led to his being employed in several missions or expeditions. Thus when, in 1867, preparations were made in India for the dispatch of an armed force against Theodore of Abyssinia, he was selected as geologist to accompany the Army. The wisdom of this selection was well proved by the excellent volume in which he gave the results of his observations during the march to Magdala and the return to the coast. Again, in 1872, he accompanied the Persian Boundary Commission, and his notes of this journey were embodied in another valuable book.

During his travels in India and beyond it, Dr. Blanford did not confine himself to the study of the rocks, but always kept a keen eye on the wild animals of each region. His published journals showed him to be as capable a zoologist as he was a geologist. Indeed, during the later years of his life his main scientific work lay amidst the fauna of British India, in regard to which his published memoirs were recognised as the chief authority on the subject. His wide experience as a traveller over the surface of the earth likewise enlisted his sympathies with geographical exploration, and made him a valued member of the council of the Royal Geographical Society.

In his writings there is often a suggestiveness or prescience that shows how keen was his insight, how far-reaching his grasp of scientific problems, more especially of those in which questions of zoology and geology were intermingled. Some of his papers in which he unfolded his views on these subjects are well deserving of attentive study. His address to the geological section of the British Association at the Montreal meeting in 1884, and his presidential discourses to the Geological Society in 1889 and 1890, may be cited as examples of his characteristic manner of treatment.

Dr. Blanford's high qualities as a man of science were fully recognised by his contemporaries. He was early elected into several of our leading scientific societies, and was chosen as a member of their councils. He received the Wollaston medal of the Geological Society and a Royal medal of the Royal Society. A few years ago, in recognition of his services to Indian science, he was made a Companion of the Order of the Indian Empire. Up to the end he continued to interest himself in the affairs of the societies with which he was connected. For years he had been treasurer of the Geological Society, and he attended the council meetings to within a few weeks before his death. His colleagues at the council board then saw with regret that his health was obviously failing, but they did not anticipate that they were never again to see his familiar face among them. A few weeks ago he was asked by the council of the Royal Society to write for them an obituary notice of his old friend and colleague, Medlicott, who had recently died. He complied with this request, and it proved to be his last piece of work. The printed proofs of his manuscript were sent to him, but before they could reach him he had become too ill to look at them. After a short illness he passed away on the morning of Friday, June 23,

in the seventy-third year of his age. He was laid to rest on Tuesday last in Highgate Cemetery, every society with which he was associated sending representatives to his funeral, while among the mourners were some of his old colleagues in India.

A. G.

NOTES.

THE Civil List Pensions granted during the year ended March 31 show more generous recognition of the claims of science than has usually been the case. The list includes the following pensions:—1904, August 8.—Mr. W. F. Denning, in consideration of his services to the science of astronomy, 150*l*. August 8.—Miss Elizabeth Parker, in recognition of the services rendered to science as an investigator by her late father, Mr. W. Kitchen Parker, F.R.S., 100*l*. August 8.—Lady Le Neve Foster, in consideration of the services rendered to mining science by her late husband, Sir Clement Le Neve Foster, F.R.S., and of the fact that his death was due to the effects of poisoning by carbonic oxide gas while carrying out his official duties, 100*l*. 1905, January 17.—Dr. J. G. Frazer, in recognition of his literary merits and of his anthropological studies, 200*l*. March 22.—The Rev. Lorimer Fison, in recognition of the originality and importance of his researches in Australian and Fijian ethnology, 150*l*. March 22.—Dr. W. Cramond, in consideration of his antiquarian researches, more particularly in connection with the ecclesiastical and burghal history of Scotland, 80*l*. March 22.—Miss L. C. Watts and Miss E. S. Watts, in recognition of the services of their late father, Mr. Henry Watts, to chemistry, 75*l*. It is satisfactory to record these tributes of national regard for lives devoted to the advancement of knowledge; and we congratulate the Government upon the great improvement which this year's list shows as regards the acknowledgment of the services rendered to the State by scientific workers.

WE regret to learn that Prof. von Tomek, president of the Imperial Bohemian Academy of Sciences at Prague, died on June 12 in the eighty-eighth year of his age.

SIR JOHN WOLFE BARRY, K.C.B., F.R.S., has been elected to succeed the late Mr. James Mansergh, F.R.S., as chairman of the Engineering Standards Committee.

THE annual conversazione of the Society of Arts will be held in the gardens of the Royal Botanic Society, Regent's Park, on Tuesday next, July 4.

THE International Institute of Sociology has accepted the invitation of the Sociological Society to hold its next congress in London in the summer of 1906. A general committee has been appointed to promote the success of the congress. Lord Avebury is the chairman of the committee, and Mr. David Mair the secretary for the time being.

THE Guy medal in silver has been awarded by the Royal Statistical Society to Mr. R. Henry Rew for his work in connection with the preparation of the reports of the special committee appointed by the society to investigate the production and consumption of meat and milk in the United Kingdom, and for his paper entitled "Observations on the Production of Meat and Dairy Products."

AMONG those who lost their lives in the railway disaster at Mentor, Ohio, on June 21 was Mr. Archibald P. Head, a brilliant young engineer and senior partner in the firm of Messrs. Jeremiah Head and Sons, of Westminster. Mr. Head was the author of several valuable papers on mining and metallurgy contributed to the Institution of Civil Engineers, the Iron and Steel Institute, and the Society of Arts.

IT is announced in the *Times* that the Board of Trade and the Trinity House have concluded a contract with Marconi's Wireless Telegraph Company (Limited) providing for the equipment of lightships with Marconi wireless telegraph installations. This arrangement will enable the lightships to communicate with the shore and with one another by wireless telegraphy for the ordinary purposes of the lightship service, and also to report ships in distress.

A REUTER telegram from Paris reports that an International Congress on Colonial Agriculture was opened there on June 22, Great Britain, Holland, Germany, Italy, Portugal, the United States, Mexico, and Brazil being represented. The members of the congress decided to form an international committee for the study of all questions relating to agricultural science and colonial industries. An organising committee, with headquarters in Paris, under the chairmanship of M. de Lanessan, has been formed.

TOWARD the close of the fourth International Ornithological Congress, an account of which appeared in our issue of last week (p. 177), a party of members paid a visit on June 20 to Cambridge. They were received by Prof. Newton, who had arranged several exhibits for the benefit of the visitors. These included a case of great auks' eggs and a selection of letters, papers, and books from Prof. Newton's library. A catalogue of these documents and books, some of them belonging to the fifteenth century, was distributed among the visitors, as was a leaflet on Legaut's giant bird by Prof. Newton explaining its origin and species. A pamphlet by Dr. Gadow on the effects of insularity, illustrated by birds of (*a*) Madagascar and Mascarene Islands, and (*b*) the Sandwich Islands, was also circulated to explain the exhibits arranged in the lecture room of comparative anatomy. A visit to the museums having been concluded, a dinner was given to Prof. Newton in the hall of Magdalene, after which Dr. Fatio in a cordial speech referred to Prof. Newton as "the father of ornithology." The congress concluded on June 21 with a visit to Flamborough Head.

DR. J. CHARCOT gave an account of his expedition to Antarctic regions before the Royal Geographical Society on Monday. The general programme of the expedition was to survey the north-west coast of the Palmer Archipelago (Hoseason, Liége, Brabant, and the Antwerp Islands); to study the south-west entrance to the Gerlache Strait, wintering as far south as was practicable, to make excursions in spring, and in summer to continue the exploration of Graham Land, with the view of elucidating the Bismarck Strait, and follow the coast as far as Alexander I. Land; in a word, to continue the labours of the Gerlache and Nordenskjöld expeditions. The expedition left Buenos Ayres in the *Français* (245 tons) on December 23, 1903, reached Smith Island (South Shetlands) on February 1, 1904, and after coasting for a few weeks was compelled by ice to return to Wandel Island, where it wintered. The temperature varied much and suddenly; the lowest was $-30°.4$ F., but a rise from $-22°$ F. to $+26°.6$ F. in a few hours was not uncommon, and was always followed by violent gales from the north-east, which broke up the ice between Wandel and Hovgaard Islands, and so prevented any move being made, in spite of many efforts. In December, 1904, a channel was made, and the *Français* returned to Wincke Island, which had been visited before

the winter set in. In January the vessel was turned north again past the Biscoe Islands, the expedition completing its survey as it went, and finally reached Puerto Madryn on March 4. Dr. Charcot expressed himself thoroughly satisfied with the results of the work of the expedition in hydrography, astronomy, biology, the measurement of tides, the analysis of colour and density of sea-water, and gravity, which was measured by means of one of M. Bouquet de la Grye's comparison pendulums. The exterior contour of the Biscoe Islands has been fixed and their breadth determined; the survey of the exterior coasts of the Palmer Archipelago completes the geography of that region, and the bearings of Alexander I. Land have been found by astronomical observation.

THE International Congress of Mining and Metallurgy at Liége, which began on June 25, and will continue until July 2, is proving a most successful gathering. Nearly fifteen hundred members have registered, and an attractive programme of papers, visits and excursions, and social functions has been arranged. Mr. Alfred Habets was elected president, and the official representatives nominated by seventeen foreign Governments were elected honorary presidents. Great Britain, though not included in this list, was represented by a strong contingent of members of the Iron and Steel Institute, and by a number of leading mining engineers. The congress was divided into four sections, dealing respectively with mining, metallurgy, applied geology, and mechanics. In the metallurgical section the first paper read was by Mr. R. A. Hadfield, who gave an account of his recent investigations of the properties of steel at the temperature of liquid air. Papers were also read on the influence of arsenic and titanium on pig iron, on the use of coals poor in agglutinating material for the manufacture of coke, and on the cutting of metals by oxygen. In the mining section several papers on shaft-sinking were read, and in the applied geology section attention was chiefly devoted to the recent coal discoveries in the north of Belgium.

WE regret to see the announcement in the *Times* that Sir Augustus Gregory, K.C.M.G., the Australian explorer, died a few days ago. Sir Augustus was born in Nottinghamshire in 1819, and entered the Civil Service of Western Australia in 1841. Five years later he began the series of explorations which were afterwards to make him famous. In 1846 he started with two brothers into the interior from Bolgart Spring, but their eastward progress was stopped by an immense salt lake which compelled them to turn north-west. The deviation led to the discovery by the party of some fine seams of coal in the country at the mouth of the Arrowsmith. Two years later he was sent northwards to explore the Gascoyne River, and he succeeded in reaching a point 350 miles north of Perth. A third exploring expedition was undertaken in 1855, this time under the auspices of the Royal Geographical Society of London. The expedition had the dual object of exploring the interior and of searching for traces of the lost explorer Leichhardt. The party was absent for nearly a year and a half, and though sure traces of Leichhardt were not found, much rich country and new watersheds were discovered. Under the auspices of the New South Wales Government, the search for Leichhardt was renewed in 1858, but again little success rewarded the efforts of the explorer. The Royal Geographical Society, however, showed its appreciation of his labours by conferring upon him the gold medal. In the following year he was appointed Surveyor-General of Queensland, and he afterwards held several posts of distinction under the Queensland Government. He was the author of several papers on Australian geology and geography.

THE editor of the Berlin *Post* has been kind enough to bring under our notice some flagrant instances of the publication in German newspapers, without acknowledgment, of translations of articles and other contributions which originally appeared in our columns. These translations have been published under the title of "Allgemeine wissenschaftliche Berichte," and the editor of the Berlin *Post* has supplied us with a list of no less than twenty cases in which articles have been taken from NATURE and translated into German without any indication of their source. The free use which has thus been made of contributions to our pages may doubtless be regarded as a flattering testimony to their scientific interest and precision; but at the same time, we must express regret that the morality of some writers on scientific subjects in Germany should have sunk so low that they can calmly render our contributions into their own language and offer the translations to newspapers as original descriptive matter. We are glad to know that this iniquitous practice has been discovered by the editor of the Berlin *Post*, and we trust that it will be exposed by the newspapers which have unknowingly printed translations of contributions to our pages.

AMONG the biological contents of the second part of the ninth volume of the *Bulletin International* issued at Prague by the Académie des Sciences de l'Empéreur François Joseph is an article by Mr. F. Brabenec on a new discovery of fossil plants in the Tertiary deposits of Holedeč, Bohemia. In addition to a new acacia, the author records remains of two species of the S. European aquatic genus Salvinia, one of which is very rare. In another article Dr. B. Němec discusses the influence of light on the position of the leaves in *Vaccinium myrtilus*, while in a third Mr. J. Smolák records the existence of multinuclear cells in certain euphorbias. The European representatives of the insect family Dictyopterygidæ form the subject of the one article, by Prof. F. Klapálek, relating to morphological zoology.

REGENERATION and development constitute the leading features of the second part of vol. lxxix. of the *Zeitschrift für wissenschaftliche Zoologie*, which contains three articles. The first of these subjects is discussed by Prof. J. Nusbaum, of Lemberg University, who takes as his text the polychæte annelids *Amphigene mediterranea* and *Nerine cirratulus*, and shows how almost every part of the organism may be reproduced. As regards development, Dr. E. v. Zeller discusses the vesiculæ seminales in newts, and Dr. E. Zander contributes an article on the male generative organs of the Microlepidoptera of the family Butalidæ. The latter communication has an interest not indicated in the title, since it discusses the statement that these insects depart from the normal type in possessing only nine (in place of ten) abdominal segments. According to the author, this is an error, due to the wrong orientation of preparations and the consequent mistaking of a true segment for part of the generative apparatus.

IN honour of the International Ornithological Congress, the current issue of *Bird Notes and News* forms a double number, of which the contents include a four-page supplement dealing with protective legislation for birds throughout the British Empire, and likewise an article on international bird-protection, in which attention is directed to the urgency of international agreement on the subject, more especially in regard to rare species, migratory birds,

and species persecuted for the sake of their plumage. Among other cases mentioned in the article on international bird-protection, special reference is made to the wholesale destruction of penguins in Macquarie Island, and perhaps elsewhere, for the sake of their oil, a destruction which if continued and extended can only result in the extermination of these remarkable and interesting birds. If certain current reports be true, not only is there need of the best efforts of the Bird Protection Society, but the Society for the Prevention of Cruelty to Animals has also a field for its operations, if its arm be long enough to reach the Antarctic.

THE amount of variation that was obtained in cultivating a five-rayed form of *Trifolium pratense* is the subject of a paper by Miss T. Tammes in part xi. of the *Botanische Zeitung*. The production of more than three rays may be regarded as the dominance of the variety, while the production of trifoliate leaves is a reversion to the original form. In the early stages, that is, on first order branches, the leaves generally showed more than three leaflets, but later the trifoliate character was almost constant.

THE avocado or alligator pear, *Persea gratissima*, is rapidly growing in favour with Americans as a salad fruit. On this account Mr. J. H. Rolfs has prepared an account of its cultivation in Florida, which forms Bulletin No. 61 of the Bureau of Plant Industry. Budding affords the most satisfactory method of propagation, as plants do not come true to seed. Two forms are cultivated, the West Indian and a smaller-fruited Mexican variety. The fruit, which only resembles a pear in shape, is eaten like an egg, without condiments or with salad accompaniments.

ALTHOUGH sandal-wood is an important source of revenue in the Indian States of Mysore and Coorg, the parasitic nature of the sandal-tree has been little studied. Mr. C. A. Barber, who originally pointed out that the sandal is a root parasite, producing haustoria, by which it absorbs nourishment from the roots of such host plants as Casuarina and Lantana, has published in the *Indian Forester* (April) an account of further investigations on the subject. The haustorial tissue penetrates the root along the line of the cambium, and thrusts aside the cortex of the host, while absorbent cells and tracheæ are formed to abstract and carry off the food solutions from the wood.

IN the *Engineering and Mining Journal* Mr. F. Danvers Power, professor of mining in the University of Sydney, publishes an important memoir on the Gympie Goldfield of Queensland. The district is of special geological interest in view of the enrichment of the gold-bearing quartz veins where they pass through four beds of black shale containing graphite. The deepest shaft in the district has attained a depth of 3130 feet.

WE have received from the Engineering Standards Committee three further reports, dealing respectively with structural steel for shipbuilding, with screw threads, and with pipe threads for iron or steel pipes and tubes. These standard specifications have been drawn up by influential committees composed of representatives of the Institutions of Civil Engineers, Mechanical Engineers and Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers, and will doubtless be generally adopted. In the case of screw threads, no departure from the Whitworth thread is recommended, and terms used by the British Association small screw gauge committee have, to a large extent, been adopted.

IN a recent paper on the determination of sulphuric acid in soils, attention was directed to the enormous loss of sulphuric anhydride due to the solubility of barium sulphate in ferric chloride solution. If such low results are obtained when determining the sulphur in the presence of small quantities of iron, what losses must be entailed where large amounts of iron are present, as in the case of iron ore? An experimental investigation of the subject has been made by Mr. J. Howard Graham, and the results are published in the *Journal of the Franklin Institute*. They show that barium sulphate is not soluble in ferric chloride to the extent mentioned, but rather that it acts restrainingly upon the act of solution of the barium sulphate in hydrochloric acid until too large quantities of the acid are present.

SINCE their discovery, the various constituents of steel have been the object of numerous researches: but the knowledge of the internal structure of steel has been to a great extent obscured by the acrimonious controversies that have been introduced into the discussion of this subject at meetings of the Iron and Steel Institute. An attempt to remove the existing confusion has been made by Dr. Glazebrook and Prof. H. Le Chatelier by suggesting the formation of an international committee to investigate the matter. The committee is composed as follows:—France: MM. Charpy, Pérot, and H. Le Chatelier; Great Britain: Mr. Hadfield (president of the Iron and Steel Institute), Prof. Arnold, Mr. Stead, F.R.S., and Dr. Glazebrook, F.R.S.; Germany: Prof. Martens; Russia: Mr. Kournakoff; Sweden: Messrs. Brinell and Gunnar Dillner; United States: Messrs. H. M. Howe and Sauveur. The scheme of investigation is published in the current issue of the *Bulletin de la Société d'Encouragement pour l'Industrie nationale*.

THE twenty-seventh report of the Deutsche Seewarte, Hamburg, for the year 1904, shows that the work of marine meteorology and weather prediction is being prosecuted with the usual vigour shown by this useful organisation, and that Admiral Herz is careful to maintain the high efficiency which it attained under the able direction of Dr. von Neumayer. At the end of the year 1904 the number of observers at sea amounted to no less than 837; they are encouraged in their work by the presentation of medals and diplomas, in special cases, in addition to free distribution of atlases and sailing directions. Eleven hundred pilot charts of the North Atlantic Ocean are published monthly, and a similar publication is contemplated for the Indian Ocean; and twelve hundred charts for the North Sea and Baltic are issued quarterly. These are in addition to the publication of larger general discussions at irregular intervals. In the department for weather telegraphy and storm warnings, it may be mentioned that the comprehensive daily weather report shows a considerable improvement by the insertion of kite observations on p. 1. Storm warning telegrams were issued on sixty days, the number of messages to hoist storm signals amounting to 2593. The report exhibits similar activity in other branches of the Seewarte.

THE report on the currents at the entrance of the Bay of Fundy and southern Nova Scotia for the year 1904 has recently been issued. The season from May to September was chiefly occupied by Mr. Bell Dawson, the surveyor in

charge of the work, in examining the currents at the entrance of the Bay of Fundy extending from Grand Manan Island to Cape Sable. These currents were found to be strong, steady, and deep, and therefore contrasted with those previously surveyed on the coasts of Newfoundland. A correct knowledge of the currents in the region surveyed is of great importance to navigation, as it includes waters that lie on the lines of ocean steamships running to St. John's, N.B., as well as of steamers from the United States ports which round the southern end of Nova Scotia on their way to Europe. It has been ascertained from the tide gauges which have been fixed during the survey and the tides recorded since 1902 that from Cape Sable westward the tides can be satisfactorily referred to St. John's, while eastward of Cape Sable they can be referred to Halifax. One noteworthy fact brought out by the survey is that the difference in range between spring tides which fall at perigee or apogee respectively is as great as the difference between mean springs and neaps, showing the dominating influence of the moon's distance in this region; and the variation in the strength of the current is found to follow the same law. Thus at St. John's the range at S.T., when the moon is at perigee, is 27·10 feet, and at apogee 20·35 feet, showing a difference of 6·75 feet. Mean spring range is 23·72 feet, and neaps range 17·43 feet, showing a difference of 6·29 feet. Also the diurnal inequality which is a dominant factor in parts of the Gulf of St. Lawrence is not very strongly marked in this region, although still quite appreciable. It was found that wind disturbance seldom affects the currents at a depth of more than ten fathoms, and that while along the centre line of the Bay of Fundy between the fifty fathoms' line on each side the ebb current runs only at the rate of $1\frac{1}{2}$ to $2\frac{1}{2}$ knots, nearer the shore about eight miles to the right or left the rate is nearly double, or from 3 to 4 knots. The report is accompanied by a map of the Bay of Fundy showing the direction and strength of the tidal currents.

AN index to the literature of indium, by Dr. P. E. Browning, has just been published by the Smithsonian Institution, and forms part of vol. xlvi. of the Smithsonian Miscellaneous Collections.

SOME remarkable finds of rare minerals have been made during the opening up of the noted gadolinite locality in Llano County, Texas; they are reported upon by Mr. W. E. Hidden in the June number of the *American Journal of Science*. The development of the mines was undertaken by the Nernst Lamp Co., of Pittsburg, Pa., and among the most notable discoveries were a double crystal of gadolinite weighing 73 lb., a mass of yttrialite weighing 18 lb., and a piece of pure allanite that weighed more than 300 lb. A single crystal of smoky quartz had a weight of 600 lb., and in a single year more than 1000 lb. of nearly pure gadolinite were extracted. Many of the minerals were radio-active, and deep work in the locality seems likely to bring to light new combinations of the rare earths and of uranium and thorium.

IN No. 4 of the *Bulletin International* of the Academy of Sciences of Cracow, M. T. Godlewski shows that it is possible to separate from actinium by a similar method to that used for isolating ThX from thorium an intensely radio-active substance to which the name actinium X is given. The residual actinium is nearly inactive, retaining only 5 per cent. of its original activity, but it recovers its activity with time according to an exponential curve; the activity of actinium X, on the other hand, decays according to an exponential curve complementary to the curve of recovery. As in the case of thorium, the emanation of actinium is shown to be due to a transformation of actinium X. A complete analogy thus appears to exist between the radio-activity of actinium and thorium. It is interesting, however, to note that actinium itself is probably inactive, whilst thorium free from thorium X has never been obtained with less than 25 per cent. of its original activity. Moreover, the β rays of actinium are completely distinct in character from the β rays emitted by other radio-active elements, inasmuch as they are completely homogeneous with regard to their absorption by solid bodies.

A PAPER by Prof. Theodore W. Richards, Lawrence J. Henderson, and George S. Forbes, which is published in the *Proceedings of the American Academy of Arts and Sciences* (vol. iv., No. 1), deals with the question of the elimination of accidental loss of heat in accurate calorimetry. It is shown that the lag of the thermometer behind the temperature of a slightly cooling or slightly warming environment causes an appreciable error in estimating the temperature of the environment; by a simple method this lag can be accurately determined and allowed for. A new method for obviating this and all other corrections for cooling is shown to consist in systematically altering the temperature of the environment at the same rate and to the same degree as that of the calorimeter proper; this may be effected by allowing a chemical action which liberates heat to take place outside the calorimeter at a graduated velocity. This method is shown in a series of experiments to give a more constant result than can be obtained by introducing a correction for cooling according to the method of either Régnault or Rumford. It is shown, moreover, to give essentially the same value as that afforded by the older methods when these are corrected for the lag of the thermometer.

IN studying the action of fluorine on some compounds of nitrogen, MM. Moissan and Lebeau found that whilst there was no reaction between fluorine and nitrogen peroxide (NATURE, June 22, p. 183) there was a vigorous reaction between fluorine and nitric oxide. In the current number of the *Comptes rendus* they give a further account of their work on this reaction, from the products of which they have succeeded in isolating a new compound of fluorine, nitrogen and oxygen, nitryl fluoride, NO_2F. The gaseous products of the reaction, cooled to the temperature of boiling oxygen, gave a white solid which on fractionation at a low temperature proved to consist of a mixture of fluorine and a new substance, condensable at $-80°$ C. By repeated distillation this latter was obtained in a pure state, and gave figures on analysis corresponding to the formula NO_2F. In the gaseous state this has a density of 2·24, the theoretical density being 2·26, a melting point of $-139°$ C. and a boiling point of $-63°·5$ C. Nitryl fluoride possesses very active chemical properties, combining at the ordinary temperature with boron, silicon, phosphorus, arsenic, antimony, and iodine. It is without action in the cold on hydrogen, sulphur, and carbon, but decomposes water, producing nitric and hydrofluoric acids, and reacts with a large number of organic compounds, giving nitro- and fluor-derivatives.

THERE will be an extra meeting of the Physical Society on Friday, June 30, at the Royal College of Science, South Kensington, when the following papers will be read:—the comparison of electric fields by means of an oscillating

electric needle: Mr. David Owen; (1) the magnetic rotatory dispersion of sodium vapour, (2) the fluorescence of sodium vapour: Prof. R. W. Wood. In addition to illustrating his papers by experiments, Prof. Wood proposes to show a number of other experiments.

At a meeting of the Faraday Society to be held on Monday next, July 3, the following papers will be read:—some notes on the rapid electrodeposition of copper: Sherard Cowper-Coles; the use of balanced electrodes: W. W. Haldane Gee; (1) electrolytic oxidation of hydrocarbons of the benzene series, part ii., ethyl benzene, cumene and cymene; (2) electrolytic analysis of antimony: H. D. Law and F. Mollwo Perkin; notes on heat insulation, particularly with regard to materials used in furnace construction: R. S. Hutton and J. R. Beard.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in July:—

July 4. 4h. Venus and Jupiter in conjunction, Venus 2° 30′ S.
,, 5. 11h. 34m. Minimum of Algol (β Persei).
,, 6. 1h. Venus at greatest elongation, 45° 44′ W.
,, 15. Venus. Illuminated portion of disc = 0·551; of Mars = 0·881.
,, 16. Uranus passes 1′ north of 1 Sagittarii (Mag. 5·3).
,, 23. Saturn. Outer major axis of outer ring = 43″·22; outer minor axis of outer ring = 6″·88.
,, 26. 11h. Conjunction of Jupiter with the Moon, Jupiter 4° 24′ N.
,, 27. 10h. 6m. Minimum of Algol (β Persei).
,, 27–31. Epoch of Aquarid meteoric shower (Radiant 339° − 11°).

New Observatory in Algeria.—The accompanying illustration of the Mustapha-Supérieur Observatory (Algeria) is reproduced from *La Nature* (No. 1671), wherein M. Lucien Libert describes in detail the situation and

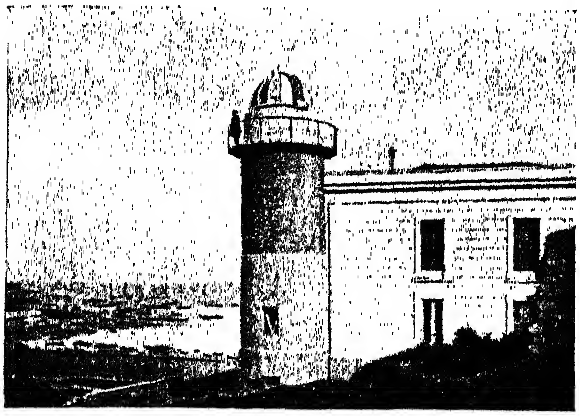

Fig. 1.—The Mustapha-Supérieur Observatory, Algeria.

equipment of the institution. This observatory was founded privately by M. Jouffray, and is situated to the east of Algiers, on a spur which forms the eastern extremity of the Sahel plateau, at an altitude of 172 metres (about 564 feet) above the sea-level. A special feature of this institution is its exclusive use of the decimal system. The equipment includes a Leroy "tropomètre," *i.e.* a centesimal chronometer, which divides the day into forty parts or "decagrades," and makes 100,000 beats per day instead of the 86,400 beats made by the ordinary chronometer. The elaborately fitted micrometer, which is used in connection with a Secretan equatorial of 135 mm. (5¼ inches) aperture and 187 cm. (6·1 feet) focal length, has its circle divided into 400 grades, the pitch of the screw being 1′ (centesimal), and M. Libert contends that the use of these scales effects an immense saving of time and labour. The electrical and mechanical arrangements for illuminating and controlling the instruments and the dome are described in detail, and appear to be as near perfection as possible. A complete meteorological equipment is also attached to the institution, and M. Libert pleads for the foundation of a similar observatory in southern Algeria, where the sky is but very rarely covered.

A Suspected Sudden Change on Jupiter.—At the meeting of the Royal Astronomical Society held on May 12, a note from Major Molesworth, R.E., was read in which he described a suspected instance of sudden change on Jupiter. Observing at Trincomalee, Ceylon, on December 17, 1903, he made a sketch of the neighbourhood surrounding the dark spot F 87, situated on the southern edge of the S. equatorial belt. This observation was made at 1h. 45·5m. G.M.T. At 2h. the observer suddenly noticed a minute white spot, bright enough to cause him some surprise at having omitted it from his previous observation, preceding and touching F 87. At 2h. 3m. this spot was so obvious that its existence could not have escaped the most casual observer, and later, at 2h. 5m., it had developed into a bright oblique rift only separated by a narrow streak from the spot F 83. This appearance lasted so long as the region remained readily observable. The region was again examined on December 20, but no trace of the outburst could be discerned. When first observed the bright spot was *preceding* F 87, but later the oblique rift appeared to enter the belt from a point immediately *following* that feature.

With a lengthy experience in observing Jupiter, Major Molesworth has never before noticed any such change in this region of the planet, but he is perfectly assured that the phenomenon was real. The observations were made under almost perfect conditions of seeing with a 12¾-inch Calver reflector fitted with a Steinheil monocentric eyepiece magnifying 270 times (*Monthly Notices*, May).

Brightness of Jupiter's Satellites.—In a recent note in these columns (May 18) attention was directed to the results obtained by Prof. Wendell from a photometric investigation of the relative brightnesses of Jupiter's satellites. He found that the invariable order of brightness of the satellites was iii., i., ii., iv., but, from a study of the photographic plates obtained at the Cape Observatory during 1891, 1903, and 1904, Prof. W. de Sitter finds that the order of magnitude was, invariably, iii., ii., i., iv., the interval ii.–i. being always of the same order as the intervals iii.–ii. and i.–iv. It thus appears that there must be a considerable difference between the visual and photographic magnitudes of these objects (*Astronomische Nachrichten*, No. 4026).

Elliptical Elements for the Orbit of Comet 1905 a.—Finding that the places derived from parabolic elements for the orbit of comet 1905 a did not agree sufficiently well with those observed, Prof. Banachiewicz calculated the following set of elements for an elliptical orbit from several observations made at various places on March 27, April 7, and April 27, and publishes the same in No. 4027 of the *Astronomische Nachrichten*:—

T = 1905 April 4·08096 (Berlin M.T.).

$$\left.\begin{aligned}\omega &= 358^\circ\ 12'\ 17''{\cdot}40\\ \Omega &= 157\ \ 27\ \ 41{\cdot}75\\ i &= 40\ \ 11\ \ 20{\cdot}76\end{aligned}\right\}1905{\cdot}0 \qquad \begin{aligned}\log q &= 0{\cdot}0470173\\ \log e &= 9\ 9856436\\ P &= 200{\cdot}62 \text{ years}\end{aligned}$$

The places derived from these elements were found to agree far more satisfactorily with the observed places.

According to a set of elements published by Herr A. Wedemayer in No. 4023 of the same journal, the period of this comet is about 279 years.

Recent Positions of Eros.—The following positions for Eros, on the dates named, have been derived from photographs taken by Mr. Manson at Arequipa with the Bruce telescope, apparently the first photographs of the asteroid to be obtained since its recent conjunction with the sun:—

1905	G.M.T. h. m.	Exposure. m.	α (1900) h. m. s.	δ (1900) ° ′
April 11	19 57	70	20 36 37	−25 4·5
12	20 41	134	20 38 34	−24 55·6
14	20 40	45	20 42 12	−24 39·1

(*Astronomische Nachrichten*, No. 4027).

TELESCOPIC WORK FOR OBSERVERS OF PLANETS.

THE possessors of telescopes now have an interesting variety of planetary objects for examination. These are Venus, Mars, Jupiter, Saturn, and Uranus.

Venus is visible, as a crescent, in the morning sky, increasing to half-moon shape in the second week of July, and arriving at her greatest elongation, west of the sun, on July 6, when her distance from that luminary will be 45° 44′. The conjunction of Venus and Jupiter will form an attractive spectacle on July 4.

Mars has now declined in diameter to 13″, but the principal markings are still very distinct, and some of the more delicate canals remain observable. After July the planet will have receded so far from the earth that further telescopic study of his physical lineaments cannot be pursued successfully.

Jupiter has just emerged into view as a morning star, rising about 2¼ hours before the sun. The most interesting point to be determined is the present position of the great red spot. The motion of this remarkable object has been curiously variable in recent years. Between October, 1904, and March, 1905, the rotation period corresponded very closely with that of system ii. of the ephemeris based on 9h. 55m. 40·63s., and the longitude remained constant at about 26°, so that the spot followed the passages of the zero meridian by 43 minutes. The exact position of the marking should be ascertained as early and as frequently as possible during the coming opposition, and the following are the probable times of a few transits during ensuing weeks:—

Date 1905	Approximate Transit Time h.	m.	Date 1905	Approximate Transit Time h.	m.
July 1	16	32	July 30	15	35
6	15	41	Aug. 4	14	45
11	14	51	6	16	23
13	16	29	9	13	53
18	15	39	11	15	32
23	14	48	13	17	10
25	16	27	21	13	49

The large dark spot seen in the south temperate zone of Jupiter in and since 1901, if still visible, will be in longitude 191° at the end of June, and will therefore follow the zero meridian by 5¼ hours and the great red spot by 4½ hours.

Saturn rises 5 hours before the sun. It is most important to learn whether there are any lingering signs of the extensive disturbance which affected the northern hemisphere in the summer and autumn of 1903. It is singular that, though a large number of observations of the spots were made and promptly reported in 1903, we have heard practically nothing of similar results in 1904. Yet the markings remained visible, if much less conspicuously, in 1904.

Uranus was in opposition to the sun on June 23, and is therefore easily discernible at the present time, though his southern declination is 23¾° An excellent opportunity will be afforded of identifying this planet during the third week in July, when he passes about 1 minute of arc north of the star 1 Sagittarii (mag. 5·3).

Added June 25.—The great red spot on Jupiter was seen by the writer at Bristol, and estimated central on June 24 15h. 43m. Its longitude was therefore 25°·1, and this sufficiently shows that its motion has exhibited no further change during the last three months.

Saturn was also carefully examined on the same morning, but no conspicuous spots were seen in a 12½-inch reflector by Calver, power 235. The observation of Jupiter was obtained with a 10-inch reflector by With-Browning, power 205. W. F. DENNING.

THE ROYAL SOCIETY CONVERSAZIONE.

THE second, or ladies', conversazione of the Royal Society was held in the rooms of the society at Burlington House on Friday last, June 23, and was attended by a large and distinguished company. As on former occasions, many objects of scientific interest were exhibited, but most of them were shown at the earlier conversazione on May 17, and have already been described in these columns (May 25, p. 90). It is therefore only necessary now to refer to additional demonstrations and exhibits.

In the course of the evening there were demonstrations, with lantern illustrations, on recent work in mimicry and protective resemblance, by Prof. E. B. Poulton, F.R.S., and on the three-colour photographic process, by Sir W. de W. Abney, K.C.B., F.R.S. The photographs in colour that were shown were prints from three negatives taken of each subject. Each of the three negatives was taken through an appropriate coloured medium, and the three transparent prints were projected on a screen with appropriate coloured screens behind them, giving the colours of nature. The process and apparatus employed were based on those of Mr. Ives.

Brief descriptions of the new exhibits are given in the subjoined abstract of the official catalogue.

The metal sodium, prepared so as to show its true colour and lustre: Mr. G. T. Beilby. The specimen was prepared by Dr. Thomas Ewan by melting the metal *in vacuo* in one vessel and running the clean, bright part of the liquid into another communicating vessel which had been freed from condensed air or moisture by heating during exhaustion. After solidification of a crystalline crust on the glass, the surplus liquid was run back into the first vessel and the specimen globe was sealed off.—(1) Pictures produced in the dark on a photographic plate by different woods; (2) ordinary photographs of the same woods; (3) the woods used in the experiments: Dr. W. J. Russell, F.R.S. The pictures taken in the dark were obtained on an ordinary rapid photographic plate, the wood being in contact with the plate from one to eighteen hours at a temperature of 55° C. The pictures were developed in the same way as if they had been produced by light.

The entoptoscope, a new form of ophthalmoscope: Prof. W. F. Barrett, F.R.S. The instrument was devised by the exhibitor for the self-examination of the eye by means of pinhole vision—entoptic diagnosis (Listing). When an illuminated fine pinhole in a sheet of metal is held near the eye, sharp shadows of any opaque or semi-opaque object in the path of the rays within the eyeball are thrown on the retina. By this means the growth of cataract from its earliest stages can be traced. By using two closely adjacent pinholes in the revolving diaphragm, and the transparent scale in the eye-piece, the exact magnitude and distance from the retina of the opacity can be determined.—The Ettles-Curties ophthalmometer and ophthalmic microscope: Mr. C. Baker. The ophthalmometer is an instrument for measuring the radius of curvature of the cornea, and consequently of ascertaining the dioptric value of the refracting medium bounded by that curvature. The instrument consists of an attachment by which the patient's head is steadied, and a telescope with Wollaston prism for observing the images of the "mires." The latter are carried on an arc graduated in terms of dioptres and radius of curvature, and prismatic steel bars provide a steady movement by rack and pinion to the adjustable parts. The whole is mounted on a telescopic floor standard which contains a plunger actuated by a spiral spring; by slight pressure this can be pushed down to the level of the patient's eye and clamped. The ophthalmometer can be detached and a microscope provided with electric illumination substituted.

Tantalum, and tantalum electric lamps: Messrs. Siemens Bros. and Co., Ltd. The exhibit comprised (1) specimens of the metal tantalum in the form of small blocks of more or less purity, also sheets and metallic powder, and specimens of wire of various thicknesses; (2) a series of tantalum glow lamps, requiring 110 volts and 0·34 ampere to give a light of 25 N.C. (1½ watts per candle-power).—The "Osmi" incandescent lamp: the General Electric Company. The lamp in appearance is similar to the ordinary electric bulb, but in place of carbon the filament is made from the rare metal osmium, which, when in a state of incandescence, glows with extreme brilliancy. The advantages claimed are:—high fusing point, white light, higher electrical efficiency, longer life, saving of current, less heat. The blackening of bulbs is inappreciable. The consumption of current with ordinary carbon filament lamp is 3·5 to 4 watts per candle-power. Consumption of current

with Osmi lamp, 1·5 watts per candle-power.—Fery radiation pyrometer: the Cambridge Scientific Instrument Company. By means of a concave mirror the image of a hot body or of the inspection hole in a furnace wall is focused upon a copper-constantan thermo-couple connected to a direct-reading galvanometer on the centigrade scale. The instrument was shown working, being sighted upon a disc of hot iron within an electrical resistance furnace.

Drawings made from combined photographs of the solar corona in 1898, 1900, and 1901: the Astronomer Royal. In 1901 a change in the corona on the west side appears to have taken place in the interval (thirty-seven minutes) between two photographs taken at different stations. The drawings were by Mr. W. H. Wesley.—(1) Photographs, maps, curves, and diagrams, in connection with the more recent researches on the astronomical significance of British stone circles. (2) Contact positives showing some of the results taken with the Solar Physics Observatory spectroheliograph. Also four enlarged pictures showing disc and disc-and-limb photographs, and a photograph of the instrument itself. (3) A series of curves to illustrate the relationship between the flow of the river Thames and pressure and rainfall changes in Great Britain. The close association between British pressure and the barometric see-saw between the Indian and South American areas was also indicated: Sir Norman Lockyer, K.C.B., F.R.S.—A new sundial that tells standard time, designed by Prof. Albert Crehore: Sir W. H. Preece, K.C.B., F.R.S. The gnomon of the common form of dial is abandoned, and the shadow of a small bead fixed on a wire is cast on the interior of a true cylindrical surface, upon which figure-of-eight curves are drawn marking standard noon for each day of the year. The cylindrical surface is inclined so that its axis, upon which the bead is fixed, is parallel to that of the earth. It thus represents the latitude of the place. The shadow of the bead travels across the cylindrical surface parallel to, or on, one of the circles drawn thereon. These circles represent days of the month. Each hour described in the circle is always of the same length, and a scale of minutes engraved on the cylinder enables true mean time to be read off directly to a few seconds.

Photographs illustrating the annual growth of a deer's antlers: Mr. H. Irving. The deer photographed was a wapiti, full grown. The first photograph showed the deer on the second day after the antlers were cast. Succeeding photographs were taken at fortnightly intervals covering four months' growth. The antlers were also shown with the velvet in strips, and finally clean and hard. The antlers of the previous year were shown for comparison.—Mendelian heredity in rabbits: Mr. C. C. Hurst. A pure-bred "Belgian hare," mated with a pure-bred white Angora, gave all wild-grey rabbits. These, bred together, gave the ten types exhibited, in which appear all the possible combinations of four pairs of coat characters, viz. short and angora, coloured and white, grey and black, self-coloured and Dutch-marked. The breeding behaviour of these types demonstrates clearly the Mendelian principles of dominance, segregation, and gametic purity. Dominant characters are short, coloured, and grey coat. Recessive characters are Angora, white and black coat. The black and Dutch-marked characters were introduced by the white Angora.—(1) Individual, local, and orthogenetic variation in Mexican lizards of the genus Cnemidophorus; (2) three specimens of *Chirotes canaliculatus* from Rio Balsas, South Mexico: Dr. H. Gadow, F.R.S. The former exhibit included:—*Cnemidophorus deppei*, showing orthogenetic variation in the number of white dorsal stripes from 7 to 11. Local variation from completely white to black underparts; from lateral white spots to double red bands. *C. striatus* and *C. guttatus*. Leading from a sharply striped pattern to the dull-coloured and completely spotted form which is characteristic of the eastern forest region. *C. gularis, C. mexicanus, C. bocourti*, and other closely allied forms, varying in size, colour, pattern, and scales.—(1) Demonstration illustrating the life-history of wood-boring wasps (Crabronidæ); (2) photographs from life of transformations of the brimstone butterfly (*Gonepteryx rhamni*): Mr. Fred Enock. The Crabronidæ, or wood-boring wasps, excavate (with their mandibles) deep burrows in decaying tree trunks, palings, &c., their work being carried on day and night until a sufficient depth has been reached. The female wasp then flies off in search of prey to stock her cells with food for the larvæ. A number of species inhabit Great Britain. Each selects its prey from certain insects, and invariably keeps to the species so selected. The intelligence exhibited by the wasp when "collecting" is marvellous, a momentary glance as the insects dart past being sufficient to identify the right one.—The membranous labyrinth of man and some animals: Dr. Albert A. Gray. The exhibit represented the membranous labyrinths of man, illustrating normal and pathological conditions; the membranous labyrinth of the seal showing otoliths; the membranous labyrinths of the mouse, the rat, the rabbit, the sheep, the cat, the lemur, the duck, the hen. The brain of the haddock, with the otoliths in their natural position.

(1) Restoration of a British Jurassic theropodous Dinosaur of the genus Streptospondylus from the Oxford Clay, Oxford; (2) British armoured Dinosaur: Dr. Francis Baron Nopcsa. The bipedal dinosaurian reptile shown in the first exhibit is the most complete representative of the genus discovered in this country. The type exists in the Paris Museum, but is very imperfect. The specimen from which Baron Nopcsa's restoration is prepared is in the private museum of Mr. J. Parker, of Oxford, and is about to be described by the exhibitor. The restoration was executed under the direction of Dr. Francis Baron Nopcsa by Miss Alice B. Woodward. Diagram reconstruction of skeleton and bony dermal armour of *Polacanthus Foxi*, Hulke, from the Wealden of the Isle of Wight. Reconstructed by Dr. Francis Baron Nopcsa, under the direction of Dr. Arthur Smith Woodward, F.R.S., and set up in the geological department of the British Museum.

Ethnological specimens from southern Mexico: Mrs. Gadow. The specimens comprised embroidered leather dancing dress; decorated cotton huipiles, from eastern Oaxaca and South Guerrero; white cotton shifts, embroidered with beads, South Guerrero; dancing masks, from Coacoyulichan, South Guerrero; clay and stone idols and sacred vessels; clay whistles, kitchen utensils, ancient and modern; copper, flint, and stone implements; and duck-shaped water vessels.

Photographs of the White Nile and its tributaries, taken by the Survey Department of Egypt, 1903: Captain H. G. Lyons. (1) Bahr el Jebel. The stations of Gondokoro, Lado, Mongalla, and Kiro; in this part the valley floor is about 2–4 feet above low-water level; at Ghaba Shambe and Hellet Nuer it is only 1–2 feet above it, and in this reach the greatest development of the marshes occurs, as well as the blocks of vegetation (Sudd). (2) Bahr el Ghazal and Bahr el Zaraf, showing their flat flood plains. (3) Sobat River in flood near its junction with the White Nile. (4) The White Nile. (5) Shilluk Negroes of the White Nile and Sobat.—Photographic views illustrative of the scenery of Tibet: the Royal Geographical Society.

SUBMARINE NAVIGATION.[1]

SUBMARINE navigation has engaged the attention of inventors and attracted general interest for a very long period. Its practical application to purposes of war was made about 130 years ago. Under the conditions which prevailed a century ago in regard to materials of construction, propelling apparatus, and explosives, the construction of submarines necessarily proceeded on a limited scale, and the type practically died out of use, almost at its birth. Enough had been done, however, to demonstrate its practicability and to make it a favourite field of investigation for inventors, some of whom contemplated wide extensions of submarine navigation. Every naval war gave fresh incentive to these proposals, and led to the construction of experimental vessels. This was the case during the Crimean War, when the Admiralty had a submarine vessel secretly built and tried by a special committee, on which, amongst others, Mr. Scott-Russell and Sir Charles Fox served. Again, during the Civil War in America, the Confederates constructed a submarine vessel, and used it against the blockading squadron off Charlestown. After several abortive attempts, and a considerable

[1] Abstract of a discourse delivered at the Royal Institution on Friday, June 9, by Sir William H. White, K.C.B., F.R.S.

loss of life, they succeeded in destroying the Federal *Housatonic*, but their submarine with all its crew perished in the enterprise.

It is impossible to give even a summarised statement of other efforts made in this direction from 1860 onwards to 1880; but one cannot leave unnoticed the work done in the United States by Mr. Holland, who devoted himself for a quarter of a century to continuous experiment on submarines, and eventually achieved success. The Holland type was first adopted by the United States Navy, and was subsequently accepted by the British Admiralty as the point of departure for our subsequent construction of submarines. In France, also, successive designs for submarines were prepared by competent naval architects, and a few vessels were built and tried. The *Plongeur*, of 1860, was a submarine of large size, considerable cost, and well considered design; but her limited radius of action and comparatively low speed left her for many years without a successor on the French Navy List.

The modern development of submarines for war purposes is chiefly due to French initiative. During the earlier stages of this development progress was extremely slow. The *Gymnote* was ordered in 1886 and the *Gustave Zédé* in 1888, and her trials continued over nearly eight years, large sums of money being spent thereon. In 1896 competitive designs for submarines were invited, but no great activity was displayed in this department of construction until the Fashoda incident two years later. Since that time remarkable developments have been made in France, considerable numbers of submarines have been laid down, rival types have been constructed, and many designers have been engaged in the work. Up to the present time about seventy submarines and submersibles have been ordered; in July, 1904, the total number of completed vessels was twenty-eight, and at the end of 1907 it is estimated that France will possess sixty completed submarines, with a total displacement of nearly 13,600 tons. The first French submarine of modern type, the *Gymnote*, was 56 feet long and of 30 tons displacement. The latest types are nearly 150 feet long and of 420 tons displacement. The cost of a French submarine designed in 1898 was about 26,000*l*. The estimated cost of the latest and largest vessels is about 70,000*l*.

Two years elapsed after the date when the French resolutely undertook the construction of submarines before the British Admiralty ordered five vessels of the Holland type from Messrs. Vickers, Sons and Maxim, who had acquired the concession for the use of the Holland Company's patents. These first vessels in essentials were repetitions of the type which had been tried and officially approved by the authorities of the United States Navy. It was agreed that all improvements made by the Holland Company should be at the service of the British Admiralty through the English *concessionnaires*. Our first five submarines are 63 feet in length, 120 tons in displacement, with gasolene engines of 160 horse-power for surface propulsion, giving a speed of 8 to 9 knots. The electric motors for submerged propulsion are estimated to give a speed of about 7 knots. The contract price for each vessel in the United States was about 34,000*l*., and that is about the price paid for our earliest vessels. The latest type of which particulars are available is said to be about 150 feet in length, 300 tons in displacement, and with gasolene engines of 850 horse-power for surface propulsion, giving a surface speed of 13 knots and a radius of action of 500 miles. The under-water speed is 9 knots, and the radius of action when submerged about 90 miles.

In French official classification a distinction is made between submarines and submersibles, and this terminology has been the cause of some confusion. Both classes are capable of diving when required, and both can make passages at the surface. In this surface condition a considerable portion of the vessel lies above the water-surface and constitutes what is technically called a "reserve of buoyancy." In the submersible this reserve of buoyancy and the accompanying freeboard are greater than in the submarine type, and in this respect lies the chief difference between the two types. The submersible has higher freeboard and greater reserve of buoyancy, which secure better sea-going qualities and greater habitability. The deck or platform is situated higher above water, and to it the crew can find access in ordinary weather when making passages, and obtain exercise and fresh air. Recent exhaustive trials in France are reported to have established the great superiority of the submersible type when the service contemplated may involve sea passages of considerable length. The French policy, as recently announced, contemplates the construction of submersibles of about 400 tons displacement for such extended services, and proposes to restrict the use of submarines to coast and harbour defence, for which vessels of about 100 tons displacement are to be employed. All recent British submarines would be ranked as submersibles according to the French classification, and it is satisfactory to know, as the result of French experiments, that our policy of construction proves to have distinct advantages.

In addition to these two types of diving or submarine vessels, the French are once more discussing plans which have been repeatedly put forward and practically applied by M. Goubet, namely, the construction of small portable submarine vessels which could be lifted on board large ships and transported to any desired scene of operations. In the Royal Navy, for many years past, it has been the practice similarly to lift and carry second-class torpedo or vedette boats about 20 tons in weight. Lifting appliances for dealing with these heavy boats have been designed and fitted in all our large cruisers and in battleships, and a few ships have been built as "boat-carriers." The first of these special dépôt ships in the Royal Navy was the *Vulcan*, ordered in 1887-8, the design being in essentials that prepared by the lecturer at Elswick in 1883. The French have also built a special vessel named the *Foudre*, which has been adapted for transporting small submarines to Saigon, and performed the service without difficulty. Whether this development of small portable submarines will take effect or not remains at present an open question, but there will be no mechanical difficulty either in the production of the vessels themselves or in the means for lifting and carrying them.

Progress in mechanical engineering and in metallurgy has been great since Bushnell constructed and used his first submarine in 1776, during the war between the United States and this country. These advances have made it possible to increase the dimensions, speed, and radius of action of submarines; their offensive powers have been enlarged by the use of locomotive torpedoes, and superior optical arrangements have been devised for discovering the position of an enemy while they themselves remain submerged. But it cannot be claimed that any new principle of design has been discovered or applied. From descriptions left on record by Bushnell, and still extant, it is certain that he appreciated, and provided for, the governing conditions of the design in regard to buoyancy, stability, and control of the depth reached by submarines. Indeed, Bushnell showed the way to his successors in nearly all these particulars, and—although alternative methods of fulfilling essential conditions have been introduced and practically tested—in the end Bushnell's plans have in substance been found the best. The laws which govern the flotation of submarines are, of course, identical with those applying to other floating bodies. When they are at rest and in equilibrium they must *displace* a weight of water equal to their own total weight. At the surface they float at a minimum draught, and possess in this "awash" condition a sufficient freeboard and reserve of buoyancy to fit them for propulsion. When submarines are being prepared for "diving" water is admitted to special tanks, and the additional weight increases immersion, and correspondingly reduces reserve of buoyancy. In some small submarines comparative success has been attained in reaching and maintaining any desired depth below the surface simply by the admission of the amount of water required to secure a perfect balance between the weight of the vessel and all she contains, and the weight of water which would fill the cavity occupied by the submarine when submerged. For all practical purposes and within the depths reached by submarines on service water may be regarded as *incompressible*; the submarine should, therefore, rest in equilibrium at any depth if her total weight is exactly balanced by the weight of

water displaced. If the weight of the vessel exceeds by ever so small an amount the weight of water displaced, that excess constitutes an accelerating force tending to sink the vessel deeper. On the contrary, if the weight of water displaced exceeds by ever so small an amount the total weight of the vessel, a vertical force is produced tending to restore her to the surface. In these circumstances, it is obvious that if the admission or expulsion of water from internal tanks (or the extrusion or withdrawal of cylindrical plungers for the purpose of varying the displacement) were the only means of controlling vertical movement, it would be exceedingly difficult to reach or to maintain any desired depth. This difficulty was anticipated on theoretical grounds, and has been verified on service—in some cases with considerable risks to the experimentalists—the submarines having reached the bottom before the vertical motion could be checked. It has consequently become the rule for all submarines to be left with a small reserve of buoyancy when brought into the diving condition. Submergence is then effected by the action of horizontal rudders controlled by operators within the vessels. Under these conditions, submergence only continues so long as onward motion is maintained, since there is no effective pressure on the rudders when the vessel is at rest. The smallest reserve of buoyancy should always bring a submarine to the surface if her onward motion ceases, and, as a matter of fact, in the diving condition that reserve is extremely small, amounting to only 300 lb. (equivalent to 30 gallons of water) in vessels of 120 tons total weight. This is, obviously, a narrow margin of safety, and necessitates careful and skilled management on the part of those in charge of submarines. A small change in the density of the water, such as occurs in an estuary or in the lower reaches of a great river, would speedily obliterate the reserve of buoyancy and cause the vessel to sink if water was not expelled from the tanks. Moreover, variations in weight of the submarine (due to the consumption of fuel, the discharge of torpedoes or other causes) must sensibly affect the reserve of buoyancy, and arrangements must be made to compensate for these variations by admitting equal weights of water in positions that will maintain the "trim" of the vessel. Additional safeguards against foundering have been provided in some submarines by fitting detachable ballast. The more common plan is to make arrangements for rapidly expelling water from the tanks either by means of pumps or by the use of compressed air. In modern submarines, with locomotive torpedoes, compressed air is, of course, a necessity, and can be readily applied in the manner described if it is desired to increase their buoyancy.

The conditions of stability of submarines when diving are also special. At the surface, owing to their singular form, the longitudinal stability is usually much less than that of ordinary ships. When submerged, their stability is the *same in all directions*, and it is essential that the centre of gravity shall be kept below the centre of buoyancy. This involves no difficulty, because water-ballast tanks can be readily built in the lower portions of the vessels. Small stability in the longitudinal sense, however, necessitates great care in the maintenance of trim, and in the avoidance of serious movements of weights within the vessels. Moreover, when a vessel is diving under the action of her longitudinal rudders, she is extremely sensitive to changes of trim, and great skill is required on the part of operators in charge of working the rudders. As the under-water speed is increased, the pressure on the rudders for a given angle increases as the *square* of the velocity, and sensitiveness to change of trim becomes greater. This fact makes the adoption of higher under-water speed a matter requiring very serious consideration. Some authorities, who have given great attention to the construction of submarines, have been opposed to the adoption of high speeds under water, because of the danger that vessels when diving quickly may reach much greater depths than are desirable. Causes of disturbance which might be of small importance when the under-water speed is moderate may have a greatly exaggerated effect when higher speeds are reached. Cases are on record where modern submarines in the hands of skilled crews have accidentally reached the bottom in great depths of water, and have had no easy task to regain the surface. For these reasons, it is probable that while speeds at the surface will be increased, under-water speeds will not grow correspondingly. Indeed, the tactics of submarines hardly appear to require high speed under water, seeing that it is an important element in successful attack to make the final dive at a moderate distance from the enemy. It is authoritatively stated that in our submarines complete control of vertical movements has been secured by means of skilled operators, and that a constant but moderate depth below the surface can be maintained. Proposals have been made and successfully applied to small submarines for automatically regulating the depth of submergence by apparatus similar to that used in locomotive torpedoes. For the larger submarines now used such automatic apparatus does not find favour, and better results are obtained with trained men.

The possibility of descending to considerable depths has to be kept in view when deciding on the form and structural arrangements of submarines, which may be subjected accidentally to very great external pressure. It is absolutely necessary to success that, under the highest pressure likely to be endured, there shall be rigidity of form, as local collapse of even a very limited amount might be accompanied by a diminution in displacement that would exceed the reserve of buoyancy. This condition is not difficult of fulfilment, and the approximately circular form usually adopted for the cross-sections of submarines favours their resistance to external pressure.

Under former conditions, there was difficulty in remaining long under water without serious inconvenience from the impurity of the air. Now, by suitable arrangements and chemical appliances, a supply of pure air can be obtained for considerable periods, sufficient, indeed, for any operations likely to be undertaken.

The use of gasolene engines for surface propulsion has many advantages. It favours increase in speed and radius of action, and enables submarines to be more independent and self-supporting. Storage batteries can be re-charged, air compressed and other auxiliary services performed independently of any "mother" ship. At the same time, it is desirable to give to each group of submarines a supporting ship, serving as a base and store depôt, and this has been arranged in this country as well as in France. With gasolene engines, care must be taken to secure thorough ventilation and to avoid the formation of explosive mixtures of gas and air, otherwise accidents must follow.

Little information is available as regards the success of "periscopes" and other optical instruments which have been devised for the purpose of enabling those in command of submarines to obtain information as to their surroundings when submerged. In this department, secrecy is obviously desirable, and no one can complain of official reticence. From published accounts of experimental working abroad as well as in this country, it would appear that considerable success has been obtained with these optical instruments in comparatively smooth water. It is also asserted that when the lenses are subjected to thorough washing by wave-water, they remain efficient. On the other hand, the moderate height of the lenses above water must expose them to the danger of being wetted by spray even in a very moderate sea, and experience in torpedo-boats and destroyers places it beyond doubt that the resultant conditions must greatly interfere with efficient vision. In heavier seas, the comparatively small height of the lenses above water must often impose more serious limitations in the use of the periscopes and similar instruments. Improvements are certain to be made as the result of experience with these optical appliances, and we may be sure that in their use officers and men of the Royal Navy will be as expert as any of their rivals. But when all that is possible has been done, it must remain true that increase in offensive power and in immunity from attack obtained by submergence will be accompanied by unavoidable limitations as well as by special risks resulting from the sacrifice of buoyancy and the great reduction in longitudinal stability which are unavoidable when diving. These considerations have led many persons to favour the construction of so-called *surface-boats* rather than submarines. They would resemble submersibles in many respects, but the power of diving would be surrendered, although they would be so constructed that by admitting

water by special tanks they could be deeply immersed and show only a small target above the surface when making an attack. There would be no necessity in such surface vessels to use electric motors and storage batteries, since internal combustion engines could be used in all circumstances. Hence it would be possible without increase of size to construct vessels of greater speed and radius of action, and to simplify designs in other important features. It is not possible to predict whether this suggestion to adopt surface-boats rather than submersibles will have a practical result; but it is unquestionable that improvements in or alternatives to internal combustion engines will favour the increase of power in relation to weight, and so will tend to the production of vessels of higher speed.

Submarines and airships have certain points of resemblance, and proposals have been made repeatedly to associate the two types, or to use airships as a means of protection from submarine attacks. One French inventor seriously suggested that a captive balloon attached to a submarine should be the post of observation from which information should be telephoned to the submarine as to the position of an enemy. He evidently had little trust in periscopes, and overlooked the dangers to which the observers in the car of the balloon would be exposed from an enemy's gun-fire. Quite recently a proposal has been made by M. Santos Dumont to use airships as a defence against submarines, his idea being that a dirigible airship of large dimensions and moving at a considerable height above the surface of the sea could discover the whereabouts of a submarine, even at some depth below the surface, and could effect its destruction by dropping high explosive charges upon the helpless vessel. Here again, the inventor, in his eagerness to do mischief, has not appreciated adequately the risks which the airship would run if employed in the manner proposed, as submarines are not likely to be used without supporting vessels. Hitherto, submarines themselves have been armed only with torpedoes, but it has been proposed recently to add guns, and this can be done, if desired, in vessels possessing relatively large freeboard. No doubt if gun armaments are introduced, the tendency will be further to increase dimensions and cost, and the decision will be governed by the consideration of the gain in fighting power as compared with increased cost. As matters stand, submarines are practically helpless at the surface when attacked by small swift vessels, and it is natural that advocates of the type should desire to remedy this condition. Surface boats, if built, will undoubtedly carry guns as well as torpedoes, and in them the gun fittings would be permanent, whereas in submarines certain portions of the armament would have to be removed when vessels were prepared for diving.

Apart from the use of submarine vessels for purposes of war, their adoption as a means of navigation has found favour in many quarters. Jules Verne, in his "Twenty Thousand Leagues Under the Sea," has drawn an attractive picture of what may be possible in this direction, and others have favoured the idea of combining the supposed advantages of obtaining buoyancy from bodies floating at some depth below the surface with an airy promenade carried high above water. Not many years ago an eminent naval architect drew a picture of what might be accomplished by utilising what he described as the "untroubled water below" in association with the freedom and pure air obtainable on a platform carried high above the waves. These suggestions, however, are not in accord with the accepted theory of wave-motion, since they take no note of the great depths to which the disturbance due to wave-motion penetrates the ocean. The problems of stability, incidental to such plans, are also of a character not easily dealt with, and consequently there is but a remote prospect of the use of these singular combinations of submarine and aërial superstructures. There is little likelihood of the displacement of ocean steamships at an early date by either navigable airships or submarines, and the dreams of Jules Verne or Santos Dumont will not be realised until much further advance has been made in the design and construction of the vessels they contemplate.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE summer meeting of the Institution of Mechanical Engineers was held last week in Belgium. The opening proceedings took place in the city of Liége, the president, Mr. E. P. Martin, occupying the chair at the preliminary sitting. Six papers were down for reading and discussion, the mornings of June 20 and June 21 being devoted to their consideration. The following is a list of the papers:—Superheaters applied to locomotives on the Belgian State railways, by M. J. B. Flamme; the growth of large gas-engines on the Continent, by M. Rodolphe Mathot; ferro-concrete, and some of its most characteristic applications in Belgium, by M. Ed. Noaillon; electric winding machines, by M. Paul Habets; strength of columns, by Prof. W. E. Lilly; an investigation to determine the effects of steam-jacketing upon the efficiency of a horizontal compound steam engine, by Mr. A. L. Mellanby.

The first paper taken was the contribution by M. Flamme on superheating for locomotives. The author first dealt with the Schmidt superheater for simple expansion locomotives as applied on the Belgian State railways. Arrangements were made for superheating the steam, in order further to increase the power of the engines. As a result of experiments made, extending over some months, it was recognised that the utilisation of steam slightly superheated did not offer any appreciable economy of fuel or increase of power. On the other hand, with the Schmidt apparatus, when the steam was superheated from 570° F. to 662° F., favourable results were obtained. Two engines were tried, one using superheated steam and the other saturated steam. The saving in favour of the superheated steam locomotive amounted to 12·5 per cent. for fuel and 16·5 per cent. for water. Moreover, the speed reached showed an average increase of 9·5 per cent., all conditions being exactly the same. In regard to maintenance, the superheated steam locomotive type did not require special attention during its one and a half years' service. These favourable results led to the Belgian State railways venturing on the application of superheat to locomotives on a larger scale. With this in view, twenty-five locomotives, comprising five different types, all provided with the Schmidt superheater, were, at the time of the reading of the paper, actually in course of construction, or were about to be put to work. The Belgian State railway authorities had decided to persevere in their experiments in combining superheating of steam with compounding of the engine. The results obtained will be of very great interest. It was desirable to find whether it was more economical to divide the superheater into two parts in such a manner as to raise the temperature at the entrance to both high-pressure and low-pressure cylinders. The Cockerill Co., of Seraing, had completed a superheater which would enable this question to be settled.

The discussion on this paper was opened by Mr. Robinson, of Messrs. Sharp, Stewart, and Co., who stated that the Schmidt superheater had been tried on the Canadian Pacific Railway, and had been found to answer, whilst on the Cape railways the results had not been so satisfactory. He attributed the latter effect to the fact that the superheating tubes were placed at the lower part of the barrel of the boiler, instead of at the upper part as they should have been. Mr. Mark H. Robinson and the president also spoke.

The next paper taken was that of Mr. Paul Habets on electric winding machines. This was a long and somewhat abstruse paper, illustrated by many diagrams, and containing a large number of formulæ. It was read in brief abstract by the secretary of the institution. The author gave a dynamic investigation of haulage, dealing with the questions of resistance, statical moments, inertia of suspended loads, inertia of rope-roll, the head gear and winding gears of motors, and other elements of design. Formulæ were given for moments of the accelerating forces and power and expenditure of energy. Details of construction of motors were discussed, and some special devices explained. As a practical conclusion, the author stated that it might be safely concluded from trials of which particulars were given that the electric haulage machine,

even if it were not more economical than the best steam-driven machines, was certainly not more expensive. The greater facility and safety with which electricity can be used, the smoothness with which it works, and its much greater flexibility, would often make it preferable to the use of steam, even in a case where transmission of energy was not required; there could be no hesitation in the choice between the two systems when the power had to be transmitted from a distance, or where the production of energy could be centralised at one power station.

M. Ed. Noaillon's paper on ferro-concrete was next read. Ferro-concrete constructions, as is well known, consist of a mass in which iron or steel reinforcement is bedded. The author stated that round bars were generally used, as they facilitated the escape of air and the proper ramming of the concrete; there were also no sharp angles which would cut the concrete. On the other hand, the round section gave the lowest coefficient of adhesion for a given cross-section of metal. The following rules governing the construction had been prepared by Prof. Rabut:—(1) No connection should be made of iron to iron, as the concrete itself holds the parts together in the most economical manner. (2) At least two distinct systems of reinforcement should be used, one to take up the tensile stress and the other to take up the shearing stresses in the concrete; when necessary a third system should be used to take up the compressive stresses. (3) The reinforcement should be so arranged that the separate members may be stressed in the direction of their length, so that the stresses produced between the iron and the concrete should be tangential, and not normal to the axis of the members of the reinforcement. (4) Homogeneity of the structure should be taken advantage of by prolonging the iron parts of one portion of the structure into the thickness of the concrete of the adjoining portion. Other points were also given.

Methods of construction were described and illustrated. Some examples of reinforced concrete were given in the paper, the handsome dome of the new Central Railway Station at Antwerp being a prominent instance. This dome is a fine piece of architecture, but was designed first of all for an ordinary masonry structure, a fact which made it somewhat difficult for the architects to adapt it for ferro-concrete. The entire structure is 1800 tons in weight, and rests wholly upon the columns at the angles of the glass lights; these columns are Y-shaped in cross-section. The external shell has a uniform thickness of 3·15 inches, and is relieved by six moulded ribs following the meridian lines. The Renommée Hall at Liége was the next example of this kind of construction. It was designed expressly for the use of this material. The principal hall is covered by three cupolas, each 55 feet in diameter, placed at a height of about 50 feet above the level of the ground. Each cupola forms part of a sphere, which continues in haunches, pierced with lights, and descending to the corners of the circumscribed square. The intersections of the spheres with the vertical spans passing through the sides of the squares are formed by arched beams, which spring from the capitals of short cylindrical columns. The cupolas are 4½ inches thick, and are made of concrete composed of cement clinker finely broken up; they are reinforced by a layer of expanded metal with a lattice work of bars. Members of the institution had a good opportunity to examine this structure, as one of the banquets during the meeting was given in the Renommée Hall.

An interesting application of reinforced concrete was also described in the widening of La Boverie Bridge at Liége. Particulars were also given of another bridge, built upon the Hennebique system; the length between abutments was 260 feet, and comprised a central span of 180 feet and two side spans. The total width of the roadway was 32·8 feet. An interesting feature about this bridge is the design of the foundations, and the way they were erected by mechanical compression of the soil. The piers and abutments rested upon a group of concrete piles driven deeply into the bed of the gravel, which thus became strongly compressed. The concrete piles were reinforced by vertical bars of steel which were continued into the piers and abutments, so that the whole was solidly bound together. By this method the advantage was obtained of solidly rooting the bridge into the earth, so that it had a resistance amply sufficient in case of a floating accumulation of ice, such as would temporarily transform the bridge into a dam. A skew bridge, also on the Hennebique system, was referred to, and a description was also given of a framework for lead chambers at the chemical works of the Engis Co. In the brief discussion which followed this paper, Mr. W. H. Maw suggested that it would be interesting if experiments could be made upon the effect of tension upon bars held in concrete. He had heard that a better hold of the concrete was obtained if the bars were previously treated to a wash of cement.

Mr. Mellanby's paper on the efficiency of the steam jacket was next read. This paper may be said to form part of a series of contributions on the same subject which have been given by various authorities during recent times. The results of a series of somewhat elaborate trials were given, from which the following general results may be taken. A compound engine, with boiler pressure at 150 lb., may be worked with the mean pressure referred to the low-pressure cylinder of about 40 lb. per square inch without any loss of efficiency in terms of the brake horse-power. Steam jackets have their maximum efficiency when the whole of the high-pressure and the ends of the low-pressure cylinders are jacketed with high-pressure steam. When jackets are applied to the high-pressure cylinder, the total indicated horse-power is slightly reduced, but when applied to the low-pressure cylinder the total indicated horse-power is considerably increased. Jackets have little effect in the high-pressure, but have considerable effect in the low-pressure cylinder upon initial condensation. The temperature supplied to the cylinder walls next to the steam must be considerably less than that of the steam, because, firstly, the actual "missing quantity" is much less than it would have been had the steam and metal gone through the same temperature changes, and secondly, because the mean temperature of the metal is higher than that of the steam. The author concluded that the greater part of the "missing quantity" must be due to leakage, and not to initial condensation, in this respect agreeing with the conclusions of Messrs. Callendar and Nicolson.

A somewhat extended discussion followed the reading of this paper. It was opened by Mr. V. Pendred, who said that compression in the cylinder had a considerable effect. If the compression corner of the indicator diagram was square, the utility of the jacket appeared to be small, but if it were rounded off by compression jacketing appeared to be more effective. Mr. Saxon, of Manchester, took exception to the statement as to a mean effective pressure of 40 lb. being the most efficient for a compound engine; he considered that the ratio of the cylinders should be taken into account. Mr. Henry Davey did not regard the results obtained as a guide for engineers, on account of the bad performance of the engine. Mr. Mark Robinson confirmed the author's opinion in regard to a mean pressure of 40 lb., and, in reply to a remark of Mr. Saxon's, said that the size of the cylinders should be in accordance with the power needed, and their ratio should be governed by the conditions of working.

On the second day of the meeting the first paper taken was a contribution by Mr. R. Mathot on large gas-engines. This was a long and interesting paper, containing a considerable amount of historical matter, and dealing with many of the details of construction by Continental makers in the design of large gas-engines, which have formed so prominent a feature of the engineering of Germany and Belgium within the last few years. The paper was illustrated by a number of engravings and diagrams, and results of engine tests were given in a table. Although English engineers early took the lead in the manufacture of gas-engines of moderate size, they have been to some extent left behind by Belgian and German manufacturers in regard to large gas-engines using blast-furnace gas; and even such of the latter as have been constructed in England have been mostly to German designs. It would be impossible in a report of this nature to give an account of the many details of construction dealt with by the author, especially without the aid of the numerous illustrations by which the paper was accompanied.

The discussion that followed the reading of the paper mainly consisted of a speech by Mr. Crossley, of Man-

chester, who defended the position of the English gas-engine makers, pointing out what had been done in the past. He did not, however, deny that the Continental makers were in advance of the English makers in regard to the size of the gas-engines manufactured.

The remaining paper was Prof. Lilly's contribution on the strength of columns, but the time for adjournment having arrived, this was only read in brief abstract, and was not discussed.

A large number of excursions and visits to works in the neighbourhood of Liége had been arranged by the local committee. Visits were also paid to the exhibition, and there were the usual social functions, including the reception, the dinner at the Renommée Hall already mentioned, and the institution dinner held at Liége. Thursday was entirely given up to these excursions, and on Friday members travelled to Antwerp, where they viewed the extensive docks of that city and some of the works in the neighbourhood. This brought a very successful meeting to a close.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. Ritchie, Fellow of New College, the present reader in pathology, has been constituted professor of pathology so long as he continues as reader. Dr. A. J. Herbertson, non-collegiate, has been appointed university reader in geography.

The Rev. H. T. Morgan, Trinity College, has offered to continue the unfinished carving in the corridors of the university museum. Much of the elaborate plan for the sculptural decoration of the museum, undertaken in 1860, has remained uncompleted, and the Rev. H. T. Morgan has generously undertaken to provide for the carving of the capitals and corbels of at least two of the four upper corridors. The delegates propose to continue the original plan, according to which the capitals were to represent various plants in systematic order.

On June 20 a deputation from the medical graduates of the university, Sir William Church, Dr. Sharkey, Dr. Shornstein, Dr. Collier, and Mr. Whitley, presented an address to the Vice-Chancellor urging the importance of pathology in the medical curriculum of the university, and stating the steps that have been taken to provide permanent endowment for the teaching of this subject. A "pathology endowment fund" has been started, and an appeal that was limited to members of the profession has resulted in the contribution of more than 500*l*. A member of the university, who has already given 1000*l*. towards the endowment of a pathology chair, has offered to cover all subscriptions from the medical faculty by an equal amount.

IT is announced that General W. J. Palmer, of Colorado Springs, Col., and Mr. Andrew Carnegie have given respectively 20,000*l*. and 10,000*l*. as a nucleus to the 100,000*l*. endowment fund for Colorado College.

MR. T. P. BLACK has been appointed demonstrator in physics in Armstrong College, Newcastle-upon-Tyne. Mr. Black was a student of the college from October, 1900, to June, 1903, when he was elected to one of the Royal (1851) exhibition scholarships.

WE learn from *Science* that the proposed affiliation of the Massachusetts Institute of Technology with Harvard University was approved at a meeting of the corporation of the institute on June 9. It was agreed to accept the terms of the agreement recently drawn up by the committee of the two institutions. Before the agreement can become effective the corporation and overseers of Harvard University must take action, and several legal questions must be settled.

THE committee appointed to inquire into the present condition of fruit culture in Great Britain, and to consider whether any other measures might with advantage be taken for its promotion and encouragement, has reported to the Board of Agriculture in favour of the establishment of a special sub-department to deal with matters connected with the fruit industry. The main recommendation is that there should be two branches of such sub-department—(*a*) a bureau of information, (*b*) an experimental fruit farm. It is further proposed that horticulture should be taught in elementary schools in country districts, that such schools should have gardens attached wherever possible, and that the attention of local education authorities should be directed to this, and also to the desirability of encouraging the study of practical horticulture in training colleges.

THE programme of the summer meeting of university extension students, which is to be held at Oxford in August, has now been published. The lectures in the natural science section will be devoted to an explanation of the scientific method and to the illustration of its application to scientific work. General introductory lectures will be delivered by Prof. T. Case, on the scientific method as an operation of the mind, and by Prof. F. Gotch, F.R.S., on the development of the scientific method. Special lectures illustrative of the applications of the scientific method to numerous branches of science have been arranged, and these lectures will be directed to show the extent to which the general conception of the particular science has been developed by the use of the scientific method, and the way in which the method is used in the experimental investigation of some group of phenomena. Among the varied list of lectures from which students may choose we notice those by Prof. W. F. R. Weldon, F.R.S., on variation and heredity; by Prof. C. S. Sherrington, F.R.S., on a general survey of physiology and psychophysics; by Prof. W. M. Flinders Petrie, F.R.S., on crucial instances in archæology; and by Dr. G. J. Burch, F.R.S., on modern conceptions of matter.

MR AILWYN FELLOWES, President of the Board of Agriculture, presided at an agricultural conference held at Aberystwyth last week. The object in view in holding the meeting was the extension and development of the work of the agricultural department of the University College of Wales by the establishment of a more definite connection between its extension work and that done inside the college, and by better organisation of the department of agriculture itself. Mr. Fellowes said that the Board of Agriculture has been able to give 800*l*. a year to Aberystwyth College and 200*l*. a year towards the college farm which was opened the same day. The college is also largely aided by the residue grant which since the year 1890 has been handed over to the county councils of the kingdom. In the counties connected with Aberystwyth College, one-sixth of the residue grant has been given to agricultural education. Mr. Fellowes said he hoped, as time went on and as Imperial funds improved, that the Board of Agriculture will be able to do more for agricultural education and for agricultural colleges. He strongly commended the suggestion that a descriptive pamphlet should be issued by the college authorities setting forth what are the proceedings of the college and what young men are able to learn there. It was decided to ask the county councils to appoint representatives to consider the details of a scheme of organisation for the agricultural department at a conference to be held in October. The following resolution was passed:—that this conference desires to record its warm gratitude to the Board of Agriculture for the invaluable aid it has rendered to agricultural education in the counties affiliated to the University College of Wales at Aberystwyth. The conference is of opinion that the results already attained and the response to the help and guidance received from the Board by the local authorities out of their limited resources constitute a strong claim for largely increased grants from the central Government towards agricultural education, which is a matter of the highest importance in the interests of the kingdom and the Empire at large. In the afternoon Mr. Fellowes opened the recently acquired college and counties' training farm, which is situate about four and a half miles outside Aberystwyth, and has an area of 200 acres.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 7.—Dr. J. E. Marr, F.R.S., president, in the chair.—The microscopic structure of minerals forming serpentine, and their relation to its history: Prof. T. G. **Bonney** and Miss C. A. **Raisin.** The authors embody their investigations in the following conclusions:—(1) That both a tint and pleochroism are accidental rather than essential characteristics of antigorite. (2) Neither are low polarisation-tints characteristic, unless two mica-like minerals exist, otherwise indistinguishable. (3) That it is doubtful whether any hard and fast line can be drawn between antigorite and the more fibrous forms in ordinary serpentine rocks. (4) That the most typical antigorite appears when the rock has been considerably affected by pressure, but it becomes less so when the latter has been very great. (5) That so far from the nearly rectangular cleavage of augite originating the "gestrickte struktur," it is worse preserved than any other original one in the process of serpentinisation. Typical antigorite, however, apparently is rather more readily produced from augite than from the other ferromagnesian silicates, but is more directly a consequence of pressure than of chemical composition.—The tarns of the Canton Ticino: Prof. E. J. **Garwood.** The lakes dealt with comprise the larger Alpine tarns which occur in the Canton Ticino. Most of these drain into the Ticino basin; one or two, however, flow into the Reuss or the Rhine. These lakes owe their origin, when they are rock-basins, to the presence of lines of weakness, along which in many cases solution has taken place, while in some shallow tarns ice may have removed detached fragments; but in no case has a lake been found which can reasonably be assigned to ice-excavation independent of rock-structure.

Mineralogical Society, June 14.—Prof. H. A. Miers, F.R.S., president, in the chair.—The chemical composition of lengenbachite: A. **Hutchinson.** A quantitative analysis of the new mineral from the Binnenthal recently described by Mr. R. H. Solly leads to the formula $7PbS.2As_2S_3$, part of the lead being replaced by silver and copper, and part of the arsenic by antimony.—The chemical composition of hutchinsonite: G. T. **Prior.** Chemical examination of this new and extremely rare mineral from the Binnenthal described by Mr. R. H. Solly showed that it could be added to crookesite and lorandite as a third mineral containing the rare element thallium as an important constituent. Quantitative analysis, made on a small amount of material (about 70 mg.), showed the presence of about 20 per cent. of thallium, and suggested the formula $(Tl,Cu,Ag)_2S.As_2S_3+PbS.As_2S_3$.—The identity of the amiantos of the ancients with chrysotile: Dr. J. W. **Evans.** The principal source of amiantos appears to have been Cyprus. Specimens brought by Prof. Wyndham Dunstan from the ancient workings on the slopes of Mount Troodos prove to be chrysotile, and not tremolite asbestos. A chemical analysis by Mr. G. S. Blake confirmed this result.—Gnomonic projection on two planes at right angles: Dr. J. W. **Evans.** By means of these projections and the rotation of one plane on an axis at right angles to the other, simple solutions of crystallographic problems are obtained.—The **President** exhibited supersaturated solutions of sodium nitrate showing the transition from the metastable condition, in which crystallisation is only possible in the presence of solid crystals, to the labile condition, in which the liquid can crystallise spontaneously.

Physical Society, June 16.—Prof. J. H. Poynting, F.R.S., president, in the chair.—On the ratio between the mean spherical and the mean horizontal candle-power of incandescent lamps: Prof. **Fleming.** This paper contains a theoretical deduction from first principles of experimental results given by Mr. G. B. Dyke in a paper read before the Physical Society on November 11, 1904, respecting the ratio of the M.S.C.P. of incandescent electric lamps to the M.H.C.P. taken when the lamp was rotating round a vertical axis. In the case of nine different types of electric glow-lamps, this ratio was found to be a number near 0·78. The author shows, by discussing the simple case of linear filament, that the ratio of the M.S.C.P. to the horizontal candle-power for this last case must be represented by the value $\pi/4=0{\cdot}785$, and hence that the constant ratio found experimentally by Mr. Dyke necessarily follows as a simple consequence of the fact that the light sent out in any direction from each unit of length of an incandescent filament varies as the cosine of the angle of inclination of the ray to the normal to the filament. In the paper it is shown also how a simple correcting factor may be obtained for reducing the actual horizontal candle-power of a linear filament of finite length to the candle-power in the same direction which would be found if the elements of the filament were concentrated on the axis of the photometer and all normal to it.—The electrical conductivity of flames: Dr. H. A. **Wilson.** The paper contains an account of a series of experiments on the conductivity of a coal-gas flame for electricity between platinum electrodes immersed in the flame. The variation of the current with the distance between the electrodes and the fall of potential along the flame are investigated by using a special burner producing a long narrow flame. The burner consists of a fused quartz tube with a series of small holes parallel to its diameter. The electrodes are two parallel discs of platinum, one fixed at one end of the flame, and the other capable of movement horizontally in the flame, so that it can be placed at any desired distance from the fixed electrode. The current through the flame was measured by a moving coil galvanometer, and the potential difference between the electrodes by an electrostatic voltmeter. The quartz-tube burner being a good insulator enables a current to be passed from one end of the flame to the other without fear of any of it going through the tube instead of through the flame. It thus enables the effect of putting salts into different parts of the flame to be easily studied.—Contact with dielectrics: Rollo **Appleyard.** Among the conclusions arrived at are the following:—(*a*) Except in the case of homogeneous dielectrics, it is misleading to deduce specific values referred to unit cube of the material from the results of tests on sheets. (*b*) With tin-foil electrodes, the apparent resistance of press-spahn diminishes as the load increases, and it attains a fairly constant value at a load of 400 grams per cm.^{2}. (*c*) If, with tin-foil electrodes, the load is gradually diminished after a load of 543 grams per cm.^{2}, the resistance gradually rises, but the rise is less rapid than the diminution in the former case (*b*). (*d*) When the full load with tin-foil electrodes is again restored the resistance falls to its minimum value. (*e*) For small loads, with tin-foil electrodes, the 2nd-minute deflection is in general greater than the 1st-minute deflection. As the load increases, a point is reached at which these deflections become approximately equal. For loads greater than about 360 grams per cm.^{2}, the 1st-minute deflection is in general greater than the 2nd-minute deflection. (*f*) Increase of voltage, with tin-foil electrodes, especially with small loads, behaves like increase of load, apparently increasing the contact area, and diminishing the observed dielectric resistance. Load, voltage, and the normal effect of "absorption" thus combine to determine the ratio of the 1st-minute deflection to the 2nd-minute deflection. (*g*) When mercury electrodes are used, the dielectric-resistance, as measured at different voltages, is sensibly the same, even for abrupt and great changes of voltage. (*h*) When mercury electrodes are used, the 2nd-minute deflection is in general never greater than the 1st-minute deflection. The inference is that when, with tin-foil electrodes, the converse is the case, it arises from imperfect contact, and not from the material itself. (*i*) When mercury electrodes are used, the dielectric-resistance, as measured with a voltage applied in a given direction, is sensibly the same as that measured with the voltage reversed, and this equality appears to become greater after a few reversals. (*j*) There is a critical load at which tin-foil electrodes yield fairly accurate results. With greater loads there is danger of crushing the material. With a less load the contact is faulty.—The pendulum accelerometer; an instrument for the direct measurement and recording of acceleration: F. **Lanchester.**—A new form of pyknometer: N. V. **Stanford.**

Royal Meteorological Society, June 21.—Mr. Richard Bentley, president, in the chair.—Normal electrical phenomena of the atmosphere: G. C. **Simpson**. In no branch of physics has the discovery of "ions," "electrons," and "radio-activity" produced a greater revolution than in that devoted to atmospheric electricity. In this paper the author endeavoured to state the chief line along which during the last few years investigations have been made and the conclusions arrived at, and also to point out some of the problems awaiting solution. The amount of radio-active emanation in the lower regions of the atmosphere is increased by all those meteorological conditions which tend to keep the air stagnant over the earth's surface. The meteorological conditions which either cause or often accompany stagnant air are calm, low temperature and high relative humidity, while, on the contrary, high winds, high temperature, and low humidity generally accompany the mixing of large masses of air. This all agrees with the observed facts that the atmospheric radio-activity increases with falling temperature, rising humidity, and increasing wind strength.—Two new meteorological instruments: G. P. **Ferguson**. The instruments described were:—(1) automatic polar star light recorder for recording the amount of cloudiness at night; and (2) the ombroscope, an instrument for determining the time and duration of rain. Both these instruments are in use at the Blue Hill Observatory, Mass., U.S.A.

PARIS.

Academy of Sciences, June 19.—M. Troost in the chair.—On the preparation and properties of nitryl fluoride: Henri **Moissan** and M. **Lebeau** (see p. 206).—On some alkyl thujones and the combinations of thujone with aromatic aldehydes: A. **Haller**. The thujone was converted into its sodium derivative by means of sodium amide in ethereal solution, and this acted upon by the alkyl iodide. The preparation and properties of methyl, ethyl, propyl, and allylthujone are described, the special object of the work being to study the influence of the introduction of the alkyl group on the rotatory power. Thujone was also condensed with benzaldehyde, anisaldehyde, and piperonal, the effect in these cases being an enormous increase in the rotatory power. Special experiments were made to see if in the course of the work the thujone had been converted into isothujone, but this was found not to be the case. An improvement in the method of preparation of isothujone from thujone is also described.—Observations on the Giacobini comet (1905 *a*) made with the large equatorial of the Observatory of Bordeaux: Ernest **Esclangon**. The observations were made on May 2 and 9.—On the influence of concentration on the magnetic properties of solutions of cobalt: P. **Vaillant**. If A be the coefficient of magnetisation of a solution containing N equivalents of water and n of salt, then $A=K'N+Kn$, where K and K' are the coefficients characteristic of the water and the salt. It was found that the value of K was nearly independent of the concentration and of the nature of the salt, the chloride, nitrate, and sulphate being studied. The slight variation of K observed would appear to be due to ionisation.—On a basic ferric sulphate: A. **Recoura**.—The chemical properties of the anhydrous chloride of neodymium: Camille **Matignon**. Hydrogen at 1000° C. has no action upon the dry chloride, no trace of a subchloride being detected. Oxygen slowly converts the fused chloride into the oxychloride, NdOCl, water giving rise to the same substance. Hydriodic acid slowly converts the chloride into the iodide, and the bromide is formed with hydrobromic acid by a similar reaction.—On a method for determining the specific heats of solutions. The molecular heat of good and bad electrolytes: P. Th. **Muller** and C. **Fuchs**. The liquid is heated by a glass spiral containing mercury through which a constant current is passed, water and the solution being alternately introduced into the calorimeter. The causes of the differences between the specific heats of solutions of electrolytes and non-electrolytes are discussed.—Researches on the mercury formates: Raoul **Varet**. A thermochemical paper.—On some new nitrodinaphthopyranic derivatives: A. **Robyn**.—On sparteine; the stereoisomerism of the two iodomethylates: Charles **Moureu** and Amand **Valeur**. These two iodomethylates cannot be distinguished by their behaviour on heating, as they both split up quantitatively into methyl iodide and sparteine, and hence the author regards the isomerism as of a stereochemical order.—The influence of electrolytes on the mutual precipitation of colloids of opposite electrical sign: Larguier **des Bancels**.—On a new form of tartrate of thallium, and on isomorphous mixtures of the tartrates of thallium and potassium: Jean **Herbette**. Although the tartrates of thallium and potassium belong to different crystalline systems, mixtures of these salts exhibit a true isomorphism; the properties of the mixed crystals of these two salts do not vary in proportion to the chemical composition. A case analogous to this has already been pointed out by Groth for a mixture of potassium chlorate and permanganate.—The action of liquid air on the life of the seed: Paul **Becquerel**. The resistance of seeds to low temperatures depends entirely upon the quantity of water and gas contained in their tissues. If this quantity of water and gas is sufficient, the cold disorganises the protoplasm and nucleus in such a manner that life is impossible, but if the protoplasm has by drying attained its maximum concentration, it completely escapes the action of the low temperature, and the seed preserves its germinating power.—An enemy of the Tonkin coffee plant, the Xylotrechus of the dry bamboo: Louis **Boutan**.—Researches on the ethnology of the Dravidians. The anthropological relations between the mountain tribes and the castes of the plain: Louis **Lapicque**.—On the presence of graptolith schists in the High Atlas of Morocco: Louis **Gentil**.—On the formation of the Rochefort Cave (Belgium): E. A. **Martel**.—On the evolution of the fossil mammals: Marcellin **Boule**. A reply to a criticism of M. Depéret.—The meteorology of total eclipses of the sun: W. **de Fonvielle** and Paul **Bordé**. Remarks on the work done by Sir John Elliot on the lowering of the temperature during the eclipse of the sun.

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THURSDAY, JULY 6, 1905.

THE EMPIRE AND UNIVERSITY LIFE.

WE publish to-day a statement signed by more than forty professors and heads of departments of the University of Oxford setting forth a scheme for large increase in the facilities for research and for teaching. We have no hesitation in stating that these forty signatures include the majority of Oxford workers with a reputation for learning which extends beyond the borders of that ancient university. They also represent, with singular completeness, the varied lines of research which happily are pursued at Oxford; and it is an encouragement among the many unsatisfactory features in the intellectual life of the nation that they are ready and willing to stand side by side, each sympathising with the needs of other workers, each desiring to grant the fullest opportunities for research on the broadest lines.

They doubtless feel in Oxford, as we recognise in London, and as Britain generally is beginning to know, that the real conflict in this country is not between science and classics, between theology and philosophy, or between the true followers of any branches of learning, but that the great educational struggle of our time and race is of an utterly different kind. On the one side are ranged those who hold that the much needed intellectual inspiration of our youth can only be received in an atmosphere of research, can only be given by men who are themselves researchers; on the opposite side stand those who uphold the ancient Chinese and the modern British educational methods. We recognise to the full the Imperial importance of the subject. Young men instructed by purveyors of second-hand word knowledge are not likely to develop the germs of imagination and originality, and to deal effectively with the problems presented in the modern world which deals with things; and the time in which such development is generally possible is all too brief. When once the critical period of intellectual growth has been devoted solely to the collection and re-collection of material for the examiner, any awakening of original power is rare indeed. We have merely created one Briton the more incapable of using his birthright, out of sympathy with the movement which would help others to gain what he has lost; and his want of sympathy may mean a great deal. He may become a journalist and help to frame the opinion of the nation, he may enter Parliament and help to marshal the educational forces upon which our future existence most surely depends, he may be a power in the Treasury and help to determine the expenditure of the national income, he may become a schoolmaster or a college tutor and do unto others even as he has been done by.

It cannot be disguised that things are in many respects worse than they were half a century ago. The University Commissioners of 1850 said of Oxford:—"It is generally acknowledged that both Oxford and the country at large suffer greatly from the absence of a body of learned men devoting their lives to the cultivation of science, and to the direction of academical education."

The commissioners of a quarter of a century later did, indeed, largely increase the number of university professors, but it left them powerless—muzzled lions chained by the leg. The whole power of influencing the passing generations of young men it left in the hands of a score of independent corporations—nearly all of them ancient, and with noble traditions of high learning and profound research; but, in the intellectual backwater of our time, each has strained to become a petty university and the successful rival of all the other petty universities—the successful rival, that is, in the qualities developed by examination, and in nothing higher. To this end each has freely spent its endowment in entrance scholarships to compete with others for the men who will do best in examinations, and each has striven to secure, before and beyond all others, the most successful purveyor of knowledge which will be useful in examinations. We say, intentionally and deliberately, that each college *has* done these things, but are far from implying that all of them have no higher aims at the present time. We are only too glad to recognise in recent years a change of spirit which has led to significant departures from the scheme of the last university commissioners. Magdalen, New College, and Brasenose have been noble leaders in a noble cause—the return of Oxford to ideals of learning which have been suppressed, but not altogether killed, by a false and injurious educational system. We gladly recognise clear evidence of the same spirit in other societies, and we are well aware that others, again, strongly desire to make provision for the highest learning, but are unable to do so while their whole available funds barely suffice to enable them to keep their place in the unfortunate and wasteful inter-collegiate competition which dominates both our ancient universities. There is, however, one college in which the necessity for such competition is reduced to a minimum, and it is precisely here that the last commissioners inflicted the crowning injury upon the intellectual life of Oxford—they set their seal on the existing constitution of All Souls. A college almost without the responsibility and the care of undergraduates is created, it would seem, to be the home of the highest learning and research. And what is it? Well, apart from a distinguished professoriate, a generous assistance to the Bodleian, and a rare and occasional election of men of learning to her fellowships—for all of which we freely and gladly express our gratitude—All Souls merely exists in order to encourage the worst features of an intellectual training which exists by and for examination alone. Only recently the governing body rejected the movement, which happily existed among some of the members, to ask for evidence of original power in the candidates who compete for the fellowships. Yet

All Souls might readily do as much for learning in Oxford by her fellowships as she now does to prevent learning—as she now does to turn the attention of the ablest men towards what will pay in examinations, and to shut their ears to the still small voice of latent imagination and original power. If All Souls gave her two fellowships each year for evidence of research, the ablest of the men studying the subjects of her choice would demand of their teachers inspiration and guidance in the highest work. Where the ablest men lead others would soon follow, and the whole intellectual atmosphere would rapidly change.

All Souls unaided could do an immense deal to induce the other colleges to provide higher teaching, or, even better, to encourage their men to get help outside the college walls. As it is, she provides the strongest of all the forces which chain Oxford to that unhappy infatuation which has had so disastrous an effect on the imagination, the initiative, the resourcefulness of the nation.

The title of this article was chosen in the profound conviction that interests much wider and more important than those of Oxford and Cambridge are at stake. Our ancient universities have heavy responsibilities, extending far beyond their historic walls. Every new university and university college in the Empire draws its teachers from Oxford and Cambridge, and, for good or for evil, moulds the broad features of its intellectual life upon the pattern supplied by these ancient seats of learning.

In the supreme interests of the Empire, as well as of the university itself, we fully sympathise with the aims of those who desire to render Oxford a more efficient instrument of research and the highest and most stimulating teaching, but we have no right to claim their sympathy or support for our own views on university and collegiate life. It may well be that the onlooker sees weaknesses and obvious measures of reform hidden from those on the spot, or appearing to them as a far-off ideal impossible of realisation, at least in this generation. Speaking for those who watch from without, who admire and would preserve and strengthen the truly inspiring elements of the academic life at both our ancient universities, we would gladly see them subject to the following simple, but, as we believe, efficient measure of reform.

The whole of the teaching should be entirely under the control of the university, which in its boards already possesses at least the foundation of the necessary apparatus. The college fellowships should be given in part for university teaching combined with original work and in part for research alone, to be held only during the continuance of investigation. A career would thus be open for originality of a high order, and the ablest men would flock to our ancient seats of learning and render them indeed worthy of the name. Residence in homes of ancient learning would gain added inspiration when the greatest traditions of the past were renewed and maintained. Even with things as they are, Oxford and Cambridge, though much injured by competitive examinations, have been far less injured than England in general; and this they owe to the residential system. Little thought of, perhaps neglected, by the builders, the head-stone of the educational edifice is here to be found. Where mind meets mind in the free intercourse of youth there springs from the contact some of that fire which, under our present system, is rarely to be obtained in any other way; and not only this, but many other priceless advantages in the battle of life are also conferred. To these influences we owe in large part all that is best in the English character, and so valuable are the qualities thus developed, or at least greatly strengthened, that we regard residential colleges as essential to the success and usefulness of the newer universities. The changes we have advocated in the older universities would only add to this beneficent system increased power for good by substituting for the barren pride of first classes and university prizes the enthusiasm for a society which nobly holds its own in those achievements which bring renown wherever the advancement of learning is held in honour—a sufficient answer to the contention that to deprive a college of teaching is to render it a boarding-house and nothing more. That the advancement of learning is the desire of those who have signed the memorial we do not doubt, however much they may disagree with the methods here suggested for the attainment of their ends. On our part we feel such confidence in the beneficent influence of the increase in efficiency for which they plead, that we should gladly see funds provided for the purpose.

In former centuries the highest learning was encouraged in this country by the munificence of "founders and benefactors"; and we are glad to know that one of the needs set forth in the accompanying statement has already been generously met, and even more than met, by the establishment of a department presided over by a Beit professor of colonial history. But the signs of the times do not encourage us to anticipate any very large or fruitful following of this fine example; and we see no prospect of carrying out the suggested scheme in anything like completeness, except by a re-arrangement of the revenues of the university and the colleges, or by the action of a Government which is convinced that the national well-being is imperilled, the national existence at stake.

THE SARCODINE FAUNA OF DEEP LAKES.

Les Sarcodinés des Grands Lacs. By Eugène Penard. Pp. 133. (Geneva: H. Kundig, 1905.)

DR. PENARD'S enthusiastic and minute investigations into this group of the Protozoa are well known. In the course of many years' study of the Sarcodina of the Lake of Geneva and of the surrounding country, he became convinced that there is a special sarcodine fauna of deep lakes. The facts on which he founded his theory, already embodied in his

two great monographs of the Rhizopods and Heliozoa, are here presented in a form more accessible to the student. About fifty species and varieties are described and figured, the majority being peculiar to deep lakes, the others characteristic of, though not confined to, deep lakes.

On looking over the diagnoses of the species, it cannot fail to be remarked that many of them are distinguished by very trivial differences from other known species. Considering the intolerable burden of synonymy in zoological nomenclature which results from the practice of describing species on insufficient grounds, it is a pity that Dr. Penard should have conferred a specific name upon a form (*Difflugia curvicaulis*, Penard) which he naïvely admits he regards as scarcely even a fixed variety. Other instances are not wanting in the volume of species which seem to be of very little value. It is obvious that he makes insufficient allowance for the recognised variability of the species of the group. He puts too much reliance on size as a specific character, and gives an exaggerated value to minute differences in the size and form of the scales which encrust many species.

Making all allowance for the slight differences on which he separates the abyssal species from the related species of shallower waters, it appears that there is really some considerable amount of peculiarity among the abyssal Sarcodina. Species tend to appear in the abyssal region under different forms or varieties from those found elsewhere. We would ask, however, whether this peculiarity is any greater than one would expect from the influence which must be exerted by the very different environment upon the individuals produced in this region?

Of interest in this country is Dr. Penard's assertion that some representatives of the abyssal fauna of the Swiss lakes have been found by him in Loch Ness. The difficulty of accounting for the passage of abyssal forms from one lake to another is just touched upon, and dismissed with the short statement that several of the species have also been found at the margins of the lakes, as well as in the depths. One is tempted to make another explanation of this fact, and say that it proves that they are not peculiarly abyssal. Dr. Penard does not say whether he regards this coming to the shore as a normal mode of migration of abyssal species.

In the special case of Loch Ness, there are facts which make it difficult to believe that the abyssal Rhizopods are peculiar species. No abyssal species of any other class has yet been found in Loch Ness. Some of the forms which are regarded as purely abyssal in the Swiss lakes are found in the shallow bays of many Scottish lochs, and even in peat bogs. This may prove an interesting fact in distribution if it can be shown that species which are superficial in Scotland have to descend to some depth in Switzerland in order to find congenial conditions of temperature. Among Dr. Penard's abyssal forms which have been found in Scottish moss may be mentioned *Heliopera petricola*, var. *amethystea*, Penard, and *Cyphoderia ampulla*, var *major*, Penard.

Making due discount for his too high appreciation of minute differences, and appraising his species at our own value, this volume is valuable to students of the Sarcodina, as there is no question of Dr. Penard's painstaking accuracy of observation. His descriptions are clear and concise, while the illustrations in the text are excellent.

STEAM TURBINES.

(1) *Steam Turbines, with an Appendix on Gas Turbines.* By Dr. A. Stodola, of Zurich. Translated from the second revised and enlarged German edition by Dr. L. C. Loewenstein. Pp. xvi+434; illustrated. (New York: D. Van Nostrand Company; London: Archibald Constable and Co., Ltd., 1905.) Price 21s. net.

(2) *Bau der Dampfturbinen.* By Prof. A. Musil. Pp. 6+233. (Leipzig: B. G. Teubner, 1904.) Price 8 marks.

(1) THE steam turbine has for some years now, thanks to the inventive genius of Mr. Parsons, become a formidable rival of the reciprocating steam-engine on land, and the past three years have seen a rapid increase in its use for marine purposes. On cross-channel steamers there is no doubt that in a few years it will completely oust its rival, while the adoption of this type of engine for two of the Allan line steamers, and the decision to use steam turbines for propelling the great Cunarders now being built, probably herald the approach of the day when on these big liners also the reciprocating marine engine will be entirely displaced.

It is not surprising, therefore, that there has grown up a rapid demand for good text-books on the steam turbine in which both the theory and the constructive details of the numerous types now on the market are fully dealt with. In addition to numerous papers and articles which have been printed in the Transactions of our leading engineering societies and in the technical journals, we have had two editions of Mr. Neilson's book, and now, by this English translation, the latest edition of Dr. Stodola's classic work is made available to British engineers.

In his preface to the second edition, Dr. Stodola points out that he has been able in the period which elapsed since the issue of the first edition to investigate experimentally several important problems untouched in the first edition, as, for example, the frictional resistance of turbine wheels in air. In the first section, after dealing with the elementary theory of the steam turbine, a concise and clear classification is given of the various types which have so far been practically successful. The more advanced thermodynamic problems which are met with in the theory of the steam turbine form the subject of the second section, and details are given of a series of valuable experiments on the flow of steam from orifices; these experiments are of great importance, and the results are very striking, and will undoubtedly prove of great value to those engaged in the design of diverging nozzles for turbines. In connection with this chapter, Mollier's diagrams for the properties of saturated steam are explained; these diagrams have been reproduced, and, for the English edition, similar

diagrams, expressed in English units, have been prepared by the translator. The design of the details of the more important types of turbines is then investigated, and such details as the shape, the construction, and the strength of the blades, and the design of the bearings of the shafts are fully dealt with.

In section iv, a full description is given of the various types of steam turbine which have so far been constructed and have been practically successful, and, in the case of several, the results of experiments by trained observers are given in detail. This portion of the book will be found of particular value to users of steam power who are anxious to have some knowledge of the relative merits of the various types of turbine now on the market. The application of the steam turbine to marine purposes is scarcely dealt with in as full and comprehensive a manner in Dr. Stodola's book as the rest of the subject, and a little more information might well have been given as to the relative merits of the steam turbine and the reciprocating engine for various purposes.

The last section of the book deals with some of the more advanced scientific problems, treated largely from a mathematical point of view, which occur in connection with the theory and construction of the turbine. We might instance such problems as that of the distribution of pressure in any cross section of an expanding gas or steam jet, the deflection, due to its own weight, of a horizontal disc of variable thickness, and the straightening out of such rotating discs under the action of centrifugal forces.

In an appendix, the possible future of the heat engine is briefly discussed; the main directions in which increased economy may be hoped for appear to be in the decrease of the passive resistances, such as friction, &c, in the supply of the heat to the motor only at the highest possible temperature and in the abstraction of the waste heat only at the lowest possible temperature, and in the avoidance, so far as possible, of all non-reversible changes of condition. Dr. Stodola is of opinion that in the future a heat motor which combines the high thermal results of the gas engine with the constructive advantages of the steam turbine will supplant all other types. Such a motor will be found in the gas turbine, a motor which at present has not reached practical constructive stages.

(2) After a brief account of the history of the steam turbine from the days of Hero, and a discussion of the lines upon which recent invention has proceeded, Prof. Musil gives a very useful bibliography; then, as is usual in books on this subject, there follows a classification of the various steam turbines now in use. The theory of the well known Laval nozzle is then dealt with mathematically, and the proportions of such nozzles are worked out in detail; the results of experimental investigation into this question are given, and the effect on the flow through such nozzles of superheating the steam is discussed. The thermodynamic problems involved in this branch of the theory of the turbine are also treated by the author with the aid of entropy diagrams.

The remainder of the book is devoted to detailed descriptions of several types of turbines, beginning with the Laval, which is described in detail with a number of illustrations. The important problems due to the use of a flexible shaft in this turbine are investigated, also the question of the governing of the turbine. The steam consumption of this type when under test is given in a series of tables, and the relation of the actual steam consumption to the theoretical is dealt with in some detail. The second type of turbine taken up is the Parsons, again illustrated with a number of well drawn plates, and here also the question of the governing of the turbine forms an important section; details of the actual steam consumption under varying loads are given, and the results have been put into the form of a series of curves, which will be of great use to the student.

It may be well to point out that Prof. Musil expressly excludes from the scope of his text-book the application of the steam turbine to marine purposes. The other types of turbines which are dealt with by Prof. Musil include the Zoelly, the Riedler-Stumpf, the Curtis, and the Rateau. For each type good descriptions of the mechanical details are given, with very clearly drawn illustrations, and in the case of the Zoelly and the Rateau results of tests are also given. Prof. Musil's book will be found of especial value by students in engineering colleges, and by draughtsmen in those engineering works where turbines are now built.

T. H. B.

OUR BOOK SHELF.

An Angler's Hours. By H. T. Sherringham. Pp. xii+264. (London: Macmillan and Co., Ltd., 1905.) Price 6s. net.

MR. SHERRINGHAM deserves the thanks of all anglers who have an idle hour and no fishing for having re-published his essays in book form, and he who is forced by sad circumstances to enjoy his fishing vicariously will find his time well spent in our scribe's company. There is a pleasant and old-world flavour in his style; whether he rises early to catch tench while the dew is still thick, or drowses away his Sunday afternoon in the July heat of a sunny garden, he is an entertaining companion, who boldly confesses to his crimes in the first person or conceals his triumphs, like Julius Cæsar, in the third with equal art. But there is instruction in his essays too, such mild instruction as may best suit an idler, and much shrewd observation of the habits of fishes delicately imparted in pointing the moral of a failure or adorning the tale of a success.

Many important considerations are thus put forward and discussed; for instance, the possibilities of the fly as a lure for other fish than trout and their kind, and the hopes held out to the fisherman who finds himself by some sluggish southern stream if he will only not despair but go forth and tempt the Cyprinids that haunt its troutless waters with flies and tackle suited to their tastes.

Again, there is the harmless, necessary worm; Mr. Sherrington handles him gently (especially when dragging him from his burrow), and adjures us to treat him as a friend in need and no mere despicable device for luring fish to an undeserved and unedifying end. We may be cursed with the instincts of a poacher, but must confess to a leaning towards that conception of the angler's art which advocates the

removal of fish from the water by the most effective means if fish are wanted, and by the most pleasant if amusement is our aim or if the waters hold few fish. We recall a schoolboy who fished for loaches with a gentle if he wanted loaches, but used a kitchen fork tied to the end of a stick if he wanted sport, and we have known others who rose superior to adverse circumstances, one who found all he wanted with a fly rod and small dace on the Cambridge Backs and another who could glory in the capture of eels with a gaff in the same unpromising water.

Mr. Sherringham has not withdrawn the veil that shrouds his early exploits, and he may have been more orthodox; but now he despairs of nothing, but finds good in all; if there are no fish he can study nature, and if there is no water he can shrewdly meditate on the ways of fish and men; an hour with him and his rod by a troutless tarn is as good as an hour by the Kennet in the mayfly time. We will not attempt to cull passages and quote them, or to draw invidious distinctions between one essay and another, but will leave each idle angler to do this for himself, with a candid admission that our own hours with Mr. Sherringham were all pleasant and instructive, but we should like more of them. A word of praise is also due to the publishers, who have produced a book the size and print of which add to its convenience as an adjunct to a pipe, an easy chair, and idleness.

L. W. B.

Botany of Cook's First Voyage. Illustrations of Australian Plants. By Sir Joseph Banks, P.R.S., and Dr. D. Solander, F.R.S. Part iii. Pp. iv+25; with 75 plates. (Trustees of the British Museum, 1905.) Price 25s.

INASMUCH as Solander was a pupil of Linnæus, this work furnishes a link with the founder of systematic botany, and it is known that Linnæus himself looked forward with great anticipation to the publication of the results of the collections made on this the first voyage of Captain Cook. The expectation was not fulfilled, and although certain of Solander's original descriptions were transcribed for sending to press, the MS. on Australian plants did not even reach this stage. A draughtsman, Sydney Parkinson, accompanied the expedition and executed a number of drawings, of which less than a third were finished for engraving purposes. Parkinson died on the voyage home, and other artists continued the work. The specimens and drawings were available, and were consulted by Gaertner and Sir Joseph Hooker, but unfortunately Bentham failed to do so when compiling his "Flora Australiensis." Possibly Banks was responsible for some of the work, but the text is taken from a MS. by Solander, and this is reproduced with brief notes and determinations by Mr. J. Britten, who has also written the interesting introduction printed with this part. In the notices of the earlier parts reference was made to some of the generic names, and, at a time when the rules of nomenclature are being discussed, it is appropriate to instance the name Banksia, that the majority of botanists associate with a genus of the order Proteaceæ, whereas Mr. Britten, in accordance with his views, adopts Isostylis, and refers Banksia to the genus of the order Thymelaceæ, otherwise known as Pimelea. This is merely quoted as an illustration of the confusion of names which renders it most desirable that a uniform system should be universally adopted. The present volume, with the two preceding parts, completes the Australian plants, and for this worthy tribute to the authors botany is indebted to Mr. Britten for his careful revision and to the British Museum for the production.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Education in Belgium and Holland.

DURING a recent cycling tour in parts of Belgium and Holland, as well as during the outward and homeward voyages on a Dutch trading steamer plying between a neighbouring Cornish port and Amsterdam and Antwerp, I have been greatly struck by several examples of the apparent educational superiority of Holland and Belgium over our own country, and at the present moment these examples may not be without interest to your readers.

(1) We were staying at a little inn near Dinant, in Belgium, and our hostess, seeing us occupied in drying some botanical specimens, brought us the herbarium of her son, a boy of about thirteen. These specimens were admirably dried and mounted, and were labelled with details concerning the characters of the order, &c., in such wise as to constitute a valuable educational asset. On inquiry, we found that the lad was a pupil at the lycée of Dinant, and that botany was a compulsory subject there, although the lad had not yet reached the stage of learning foreign languages. The boy himself was so bright and intelligent, and so brimful of enthusiasm for botany, that we at once supposed him to be exceptionally intelligent; but some old friends of the family informed us that until a year ago he was shy and "lumpish," and that the transformation had been effected by the lycée. Commend me to such schools!

(2) The skipper of the Dutch steamer on which we returned told me that in the elementary schools of Amsterdam the children are taken at intervals to the "Zoo" to receive object-lessons on the animals about which they read at school, and on other occasions are taken into the fields to receive object-lessons on the wild flowers; and what struck me especially was that this "mere sailor"—this skipper of a tramp steamer—fully appreciated the value of such practical instruction as giving an interest and sense of reality to his children's school-work. It was also rather surprising to hear such a man express the opinion that a little knowledge of astronomy rendered certain theological doctrines impossible of belief.

(3) The skipper of the outgoing Dutch steamer explained to me that the standard for mates' and masters' certificates in the Dutch mercantile marine is higher than in ours, there being three stages of mates' certificates instead of our two, and that before taking out a master's certificate it is necessary to attend a course of simple medical instruction for some months—surely a very reasonable regulation. On the subject of Englishmen's usual inability to speak a foreign language, he opined that this inability was due to our laziness—not realising, probably, the absurdities of our traditional school system.

(4) The second mate of one of these steamers—a rough lad of twenty-one—seeing me reading a volume of verse in a well known "series" with distinctive binding, asked me if I knew a book like that with Longfellow's poetry, for he had it at home and liked it! I cannot imagine an Englishman of the same age and status knowing a poet even in his own language, much less a foreign poet.

I must not occupy your space by drawing from these facts the moral that is obvious enough, but will conclude with two statements on which it is not pleasant to reflect. These Dutch steamers have driven out a line of English steamers which formerly traded between Fowey and Antwerp, and now practically monopolise the china-clay trade between these two ports; and of the total crews of forty-one carried by the two boats mentioned above, thirty-nine were Dutchmen and two were Germans from the Dutch border, whereas everyone knows that on English vessels often only a small minority of the crew are English. Are such results surprising?

F. H. PERRY-COSTE.

Polperro, Cornwall, June 22.

The "Bubbling" Method and Vapour Pressures.

IN the course of an endeavour to determine the osmotic pressure of a solution by measuring the relative lowering of its vapour pressure, we have been led to abandon Oswald and Walker's bubbling method on account of its inherent inaccuracy.

As the disabilities of this method seem to have been overlooked, we think that this note may be of use to other workers in the same field.

Oswald and Walker, it will be remembered, bubbled dry air through the solution, then through the water, and absorbed the moisture by means of sulphuric acid. The loss of weight of the water measures the relative lowering of the vapour pressure of the solution, and the gain in weight of the sulphuric acid represents the vapour pressure of the pure solvent, water.

Assuming the air to be at the same temperature throughout, it can easily be seen that the space occupied by a bubble of air, when leaving the solution, will be less than that which the same bubble will occupy when leaving the water, that is, the bubble expands while travelling up the water column, and will have taken up more water vapour than it should. The expansion of the bubble (and consequently the amount of vapour necessary to saturate the space occupied by it) is proportional to the difference in pressure at the top and bottom of the water column. If the total depth of the latter be, say, 6 inches, and the barometer stand at 30 feet of water, then an error of 1 part in 60 is induced.

This can conveniently be verified by passing air through two or more Winkler's tubes filled with water; it will always be found that the exit tube has lost weight. Owing to the form of the equation connecting osmotic and vapour pressures, the effect of the above error is magnified.

BERKELEY.

Foxcombe, near Oxford. E. G. J. HARTLEY.

Luminosity and Colour.

IN conjunction with my other methods of testing colour vision, I have been using Rayleigh's apparatus for matching yellow with a mixture of spectral red and green. I find that the proportions of red and green depend upon the luminosity of the match (both the mixed colour and the simple one being of similar luminosity); for instance, I require two and a half times as much green in the mixed colour when the match is bright compared with a match at a lower luminosity. Some persons make a match which is nearly the same at several luminosities, others require more and more green as the luminosity is diminished, and others when the luminosity is diminished cannot make a match at all. So three normal sighted persons may make a similar match at one luminosity, and at another one may appear to be an anomalous trichromatic and the other colour blind. I find that a colour blind person (a dichromic with considerable shortening of the red end of the spectrum) may make a match like a normal sighted one. F. W. EDRIDGE-GREEN.

St. John's College, Cambridge.

MEETING OF THE BRITISH ASSOCIATION IN SOUTH AFRICA.

THE arrangements for the forthcoming meeting of the British Association in South Africa have now been completed, and Mr. Silva White, the assistant secretary of the association, sailed for Cape Town in the *Walmer Castle* on Saturday last, July 1. The number of members who will proceed to South Africa to attend the meeting is 385, and of these no less than 276 members have intimated their intention to visit the Victoria Falls at the conclusion of the ordinary work of the association. The official party, consisting of leading representatives of science and guests of the association, with the general and sectional officers for this meeting and the president, numbers 140 in all, and will sail by the *Saxon* on July 29. Most of the other members will proceed to the meeting by the *Durham Castle* and the *Kildonan Castle*, both of which sail on July 22.

In a previous article (May 18, p. 59) the local arrangements for the meeting were described. There will be receptions and social functions, excursions, &c., at Cape Town, Durban, Pietermaritzburg, Johannesburg, Kimberley, and Bulawayo. The central organising committee for South Africa (chairman, Sir David Gill, K.C.B., F.R.S., hon. secretary, Dr. Gilchrist) has carried out the coordinating work of the programme. The lists of local committees and subcommittees contain nearly one thousand names, from which it may be concluded that much interest is taken in the meeting.

As already mentioned, lectures of a popular character will be delivered at the chief towns visited. These lectures have now been definitely arranged as follows:—

Cape Town: W. J. Burchell's discoveries in South Africa, Prof. Poulton; some surface actions of fluids, Mr. C. V. Boys. *Durban:* Mountains: the highest Himalaya, Mr. D. Freshfield. *Pietermaritzburg:* Sleeping-sickness, Colonel D. Bruce. *Johannesburg:* Distribution of power, Prof. Ayrton; steel as an igneous rock, Prof. Arnold. *Pretoria:* Fly-borne diseases, malaria, sleeping-sickness, &c., Mr. A. E. Shipley. *Bloemfontein:* The Milky Way and the clouds of Magellan, Mr. A. R. Hinks. *Kimberley:* Diamonds, Sir William Crookes; bearing of engineering on mining, Prof. Porter. *Bulawayo:* Zimbabwe, Mr. Randall-MacIver.

The president's address to the association will be delivered at Cape Town on August 15, and at Johannesburg on August 30. Mr. G. W. Lamplugh's report on the geology of the Victoria Falls will take the form of an afternoon address to Section C at Johannesburg.

Subjoined is a draft programme of the work of the sections:—

Section A (Mathematics and Physics).—*Cape Town:* President's address; progress of the arc of meridian and geodetic survey of South Africa, Sir D. Gill; to what extent can the ether affect the motion of matter? Prof. J. Larmor; observations of atmospheric electricity in South Africa, Prof. Beattie and Mr. Lyle; leak of electricity from certain heated substances, Prof. Beattie; the foundations of the kinetic theory of gases, Mr. Burbury; application of the kinetic theory of nebulæ, Mr. J. H. Jeans; radiation at low temperatures, Dr. J. T. Bottomley. There will also probably be communications from Mr. Hough on tides, and from Dr. Roberts on the Algol variables. *Johannesburg:* On the teaching of elementary mechanics (jointly with Section L if possible), Prof. J. Perry; on flight, Prof. G. H. Bryan; (1) electrical conductivity in relation to chemical action; (2) magnetic survey of South Africa, Prof. Beattie; report of the seismological committee, Prof. J. Milne; a form of dry Daniell cell, Mr. J. Brown; the strength of winding ropes in mines, Prof. Perry; the experimental foundations of the theory of heat conduction, Dr. C. H. Lees. There will probably be a communication from Mr. Sutton on the meteorology of South Africa.

Section B (Chemistry).—Detailed information regarding papers offered by members in South Africa has not yet been received, but the following provisional arrangement has been made:—*Cape Town:* Recent advances in agricultural science, A. D. Hall; vegetable assimilation, Dr. Horace T. Brown; enzyme action, Dr. E. F. Armstrong. These communications are intended to serve as a basis of discussion of agricultural chemical problems. *Johannesburg:* President's address; reports on various aspects of the metallurgy of gold by local experts. Communications by Dr. H. Marshall on the experimental basis of the dissociation hypothesis, and by H. Ingle on the soils of the Transvaal, have been provisionally accepted.

Section C (Geology).—*Cape Town:* Opening remarks by the president; the continent of Africa in relation to the physical history of the earth, Prof. W. J. Sollas; the classification of the Karroo beds of South Africa, Prof. R. Broom; report of the committee on the fauna and flora

of the English Trias, J. Lomas; extraordinary daily fluctuations in a Karroo well, Prof. A. Young; and other papers on the Karroo or Trias. *Joint meeting with Section E (Geography)*.—The physical geography of Cape Colony, H. C. Schunke-Holloway; Glacial periods in South Africa, A. W. Rogers; changes of climate, as shown by movements of the snow line and upper tree line since Tertiary times, Prof. A. Penck; physiographical subject, Prof. W. M. Davis; Baviaan's Kloof, a contribution to the theory of mountain folds, E. H. L. Schwarz; the Stormberg formation in the Cape Colony, A. L. Du Toit; on the geology of South Victoria Land, H. T. Ferrar. *Johannesburg:* President's address; magnetic segregation of sulphide ores, Dr. A. P. Coleman; marginal phenomena of granite domes, Prof. G. A. J. Cole; relation of the igneous rocks to the crystalline schists, F. P. Mennell; the indicators of the goldfield of Ballarat, Prof. J. W. Gregory; petrographical subject, Prof. R. B. Young; the diamond pipes and fissures of South Africa, H. S. Harger; recent work of the Transvaal Geological Survey, H. Kynaston; the Victoria Falls, G. W. Lamplugh; the great laccolitic intrusions of the Bushveld, Dr. G. A. F. Molengraaff; evidences in the Transvaal of Glacial conditions in permo-Carboniferous times, E. T. Mellor; geological notes on the excursion to Pretoria, A. L. Hall; the great West Rand upthrust, Dr. J. T. Carrick; notes on a sedimentary formation older than the Witwatersrand beds, E. Jorissen; interesting outlines of the Witwatersrand formation, Dr. J. T. Carrick.

Section D (Zoology).—*Cape Town:* President's address; the Triassic reptiles of South Africa, with remarks on the origin of mammals, Dr. Broom; a comparison of the Permian reptiles of Russia with those of South Africa, Prof. Amalitzky; South African scorpions, Dr. Purcell; recent work on gametogenesis and its bearing on theories of heredity, L. Doncaster; the migration of birds in the southern hemisphere, W. L. Sclater; the ostrich, A. H. Evans. *Johannesburg:* Pearl oysters and pearls, Prof. Herdman; recent discoveries in the South African deep sea, Dr. Gilchrist; cephalodiscus, Dr. Harmer; the growing-point in vertebrates, Prof. Cleland; South African ticks, Drs. Cooper-Foster and Nuttall.

Section E (Geography).—*Cape Town:* President's address; afforestation of South Africa; the unveiling of the coasts of Africa (lantern views of old maps), H. Yule Oldham; the Ordnance Survey of the United Kingdom, Colonel Johnston; a comparison of the periodicity of the meteorological conditions of London and Cape Town, Dr. H. R. Mill; Gough Island, Rudmose Brown; terrestrial globes as a necessary adjunct to the teaching of geography, Captain Creak; excursions as a means of teaching geography (lantern), J. Lomas. *Johannesburg:* The evolution of Africa, Dr. J. Scott Keltie; a new rainfall map of Africa, A. J. Herbertson and P. C. Waite; boundaries and areas in Africa, J. Bolton; the physical geography of the Transvaal, Tudor Trevor; notes on the geography of Africa south of the Limpopo, F. S. Watermeyer; the game preserves of the Transvaal, Major Stevenson Hamilton, D.S.O.; the Sikhim Himalayas and Tibet, Douglas W. Freshfield; Asiatic subject, Prof. Cordier.

Section G (Engineering).—*Cape Town:* Metcalfe on Zambezi Bridge and Rhodesian railways; ocean turbine boats, Prof. Byles; roller bearings, wire ropes in mines, and probably automobiles. *Johannesburg:* President's address (irrigation); strength of winding ropes in mines, Prof. Perry.

Section H (Anthropology).—*Cape Town:* President's address; the totemism of the Bantu, E. S. Hartland; the musical instruments of the natives of South Africa, Hy. Balfour; American Negroes, Miss Pullen-Burry; artificial deformation in Africa, Dr. von Luschan. *Johannesburg:* arts and crafts among the natives of South Africa, Dr. Schoenland; stone implements in South Africa, Mr. Johnstone; bushman paintings with reproductions, Dr. Squire; the affinities of the Hottentots, Dr. von Luschan; the Modjadje, Rev. Reuter; the Bawenda, Rev. Gottschling; report on Zimbabwe, Mr. MacIver; the Basuto, H. E. Mabille.

Section I (Physiology).—*Cape Town:* Discussion on the effect of climate on health, opened by Sir T. Lauder Brunton (Dr. David Ferrier, Prof. McKendrick, Dr. Gregory, Dr. Jasper Anderson, Prof. Bohr, and Dr. J. A. Mitchell will take part); so-called scurvy of South Africa, Dr. Gregory; on plague, Dr. J. A. Mitchell; leprosy in Cape Colony, Dr. A. S. Black; South African drugs, Dr. Moberley; discussion on horse-sickness and allied diseases, opened by Dr. Edington (Dr. Hutcheon, Mr. du Plessis, Dr. Wm. Robertson, Colonel Bruce, and Prof. Sims Woodhead will take part); stock diseases in South Africa, Dr. Hutcheon; ticks as a means of conveying disease in South Africa, Mr. Lounsbury. *Johannesburg:* President's address; horse-sickness, Dr. Theiler; rinderpest, Dr. G. Turner; a discussion on lung diseases in connection with mining (Dr. Sims Woodhead) is under consideration; nervous diseases, Prof. Ferrier; the life-history of coloured labourers in the Transvaal, Dr. D. Macaulay and Dr. Louis Irvine; dysentery, Colonel Cecil Birt.

Section K (Botany).—*Cape Town:* The present position of our knowledge of seaweeds, Prof. R. W. Phillips; the fossil floras of South Africa, A. C. Seward; educational methods in the teaching of botany, Harold Wager; notes on irrigation farming on the Orange River, F. B. Parkinson. *Johannesburg:* President's address; photography as an aid to œcological research, Prof. F. E. Weiss; the problems of heredity, R. P. Gregory. It is expected that Prof. Engler, Prof. Pearson, and others will contribute papers.

Section L (Educational Science).—*Cape Town:* President's address; the teaching of science, Prof. H. E. Armstrong; the teaching of science in South Africa, Dr. Hahn; rural education, appropriate to colonial life in South Africa, and agriculture, A. D. Hall; the higher education of women in South Africa, Miss Clark; disabilities of South African school boys, W. A. Way; Cape education, its difficulties and development, Rev. W. E. C. Clarke. *Johannesburg:* Changes in the Dutch language since its introduction into South Africa, Dr. Brill; education on the veldt, Mr. Corbett; prospects of secondary schools in the Transvaal, Mr. Hope; teaching of agriculture, F. B. Smith; native education, Hobart Houghton; progress of education in the Transvaal, H. Warre Cornish; education in Rhodesia, G. Duthie; a school of forestry, T. R. Simms; the teaching of architecture, R. G. Kirkby; education in the Orange River Colony, Hugh Gunn; manual instruction in the Transvaal, T. Lowden; recent improvements in the training of infants, with special reference to South Africa, Miss Welldon; discussion with Section A, the teaching of elementary mathematics.

THE PRINCIPLES OF GEOLOGY.[1]

THE principles are, notwithstanding the origin of the word, the last things you attain to in the course of scientific investigation; but they are what you first explain to another who is commencing his study. You may make a further selection of such parts as are for any reason the easiest or most suitable for him to begin with, and call them the elements. Lyell's classic work has pretty well fixed what shall be the conventional meaning of "The Principles of Geology." They are the laws or explanations which we arrive at in respect of the phenomena exhibited in the earth's crust from direct observation of those phenomena themselves or of the recent operations of nature which we see producing analogous results. Their value depends upon the opportunities afforded of obtaining evidence and upon the personal faculty of eliminating sources of error.

In the case of geology, the subject is so vast that its different branches are growing further and further apart, until they seem to have an intergrowth with the branches from other subjects the original stem of which was far removed from their own.

From the observation of rock masses inferences have been drawn as to the conditions which prevailed in past times, and theories have been propounded as

[1] "Structural and Field Geology." By Dr. Jas. Geikie. Pp. xx + 435. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson, 1905.) Price 12s. 6d. net.

to the forces which have rolled up the strata and produced such varied superficial and deep-seated phenomena. These form the principles of dynamical geology, and it is the description of the resultant structures and the methods of observation which form the chief subject of the interesting handbook just published by Dr. James Geikie under the title "Structural and Field Geology."

The two first chapters are devoted to an examination of the rock-forming minerals. These are very few in number if we leave out all except those which are the essential constituents of the common rocks.

After studying their composition and characteristics in hand specimens or small slices adapted for examination under the microscope, there is much to be learnt as to the history of the earth's crust from the observation of large masses of rock. We can see whether they were laid down in comparatively tranquil water, or hurled along by torrents, or dashed against a shore. We notice that what was once mud or sand or shingle is now solid rock, and we try to make out in each case whether this was brought about by the introduction of some cementing material or caused by the pressure of superincumbent masses, and whether the changes were helped by the action of the high temperature experienced by rocks depressed to great depths or crushed by irresistible earth movements. Chemical reactions and the crystallisation of various minerals out of the material of the rock produce changes on a small scale, as seen in concretions and drusy cavities, or on a large scale as in the case of the formation of vast beds of crystalline limestone from the calcareous fragments of various organisms. We can infer from a comparison of certain rocks with the products of recent volcanoes that ancient volcanoes also injected molten matter through the riven rocks, poured out vast sheets of lava, and covered wide areas with volcanic ash.

Photo. by H.M. Geological Survey.

Fig. 1.—Fault-rock, River Garry, at Dalnacardoch, Perthshire. (Reproduced on a reduced scale from "Structural and Field Geology," J. Geikie.)

The rocks so formed and so altered have yet to be regarded from another point of view. They have been depressed, uplifted, and thrown into all sorts of positions, now being dragged out, now crumpled up into every variety of fold, the compressible portions often making up by vertical thickening what they lose in horizontal extent, and those that would not yield to such molecular re-arrangement being reduced to the same dimensions by crumpling.

Divisional planes are developed in them, some being due to crush, some to shrinkage, some to the variety in the succession of deposits, and when the strained and bending rock must break it is apt to give along these lines of weakness, so that we find faults commonly coinciding with master joints, thrusts with bedding planes, and so on.

The last seven chapters are more specially devoted to the second subject in the title of the book, namely, field geology. This could not be altogether dissociated from the observations recorded in the earlier part of the work. The information there given is the outcome of original observations in the field, but our author now deals more with the methods employed, and explains what are the most useful appliances for the work and what are the indications which the surveyor must be on the alert to detect. Perhaps, having regard to the numerous monographs which have recently been published on the subject of scenery, he has given greater prominence to the causes than to the effects, to the earth structures to which most scenic features must ultimately be referred rather than to the total result of movement and denudation by which anomalous river flows and abnormal features must be explained.

A study of recent organisms enables us sometimes to establish the relation between the soft and perishable parts and the hard parts which alone are commonly preserved in the rocks, and thus by a comparison of the fossil forms with their nearest recent representatives to learn something of the order of succession of life upon the earth and the conditions under which fossil plants and animals existed. Such analogies must not, however, be pressed too hard. Even such a recent case as the occurrence together of the remains of lion, hyæna, and hippopotamus with the hairy elephant and woolly rhinoceros in our gravel terraces can hardly yet be said to have received an altogether satisfactory explanation. Before we draw inferences from the abundance or rarity of certain fossil organisms we must carefully consider their mode of entombment and the conditions which favour the preservation or the destruction of their remains.

Dr. Geikie has dealt very shortly with these principles of palæontology, but devotes most of his work to the inorganic side of geology.

Even with this limitation of subject the work takes a somewhat encyclopædic character owing to the great number and variety of the observations and inferences which have to be recorded. The treatment is rather dogmatic than critical. With an author so experienced and acute in observation this may be for many an advantage, but students require a discussion of arguments where conclusions differ, and references to other authors where they may find the matters more fully treated which are here of necessity briefly stated.

The formation of ripple marks, for instance, wants fuller explanation than the statement that "they owe their origin to a wave-like motion set up in the semifluid sediment by the water passing over it."

The work is illustrated by a large number of diagrammatic sketches by the author and photographs by members of the staff of the Geological Survey. As examples, we reproduce the pictures of two common phenomena which have many points of general resemblance to one another but a very different origin. Plate xxxix. represents a fissure the strata on either side of which have been relatively displaced by earth movements, either repeatedly in one direction or with a to-and-fro motion, so that the walls of the fissure have been rubbed smooth, fluted, and polished by the movement. The triturated rock and the fragments broken off fill the crack, and this débris is often penetrated by mineral matter and consolidated into a mass harder than the rocks through which it passes. The walls of the fissure are sometimes altered mechanically and by infiltering water to a considerable depth.

In Plate xliv., on the other hand, we see a rift in the rocks filled with matter which has welled up from deep-seated rock which has become molten. In this case, also, the immediately adjoining portion of the rock which it traverses is altered, and very commonly shows slickensides when earth movements have acted upon these two rocks of such different tenacity and hardness; but the composition of the traversing rocks is so unlike in the two cases, and the character of the marginal alterations so dissimilar, that there is seldom any room for doubt as to the origin of each.

Our author has wisely avoided most of the shibboleths which it is the fashion for specialists to introduce into their explanations of the simplest phenomena, but though students may escape the interruption of having to consider the exact application of mylonisation and schillerisation, which are not in the index, though one is found in the text, they must learn the meaning of such terms as synclinorium or geanticline. Difficulties and absurdities in nomenclature are perhaps characteristic of the present phase of scientific literature, and our author has been wonderfully considerate in this matter, and has given us a very useful handbook, admirable in the freshness and terseness of its descriptions and the clearness and abundance of its illustrations.

Photo. by H.M. Geological Survey.

Fig. 2.—Basalt Dyke Cutting Sandstone and Shale, Kilbride Bennan, Arran. (From "Structural and Field Geology," J. Geikie.)

NOTES.

AMONG those who are the recipients of the King's birthday honours we notice the following:—Lord Rayleigh, O.M., F.R.S., has been made a Privy Councillor; Knighthoods have been conferred upon Prof. T. McCall Anderson, of the University of Glasgow; Mr. E. W. Brabrook, C.B., formerly Registrar of Friendly Societies; Dr. A. B. W. Kennedy, F.R.S., Emeritus professor of engineering and mechanical technology at University College, London, and president of the Admiralty Committee on Machinery Designs; Dr. Boverton Redwood; and Dr. W. J. Smyly, president of the Royal College of Physicians, Ireland. Colonel D. Bruce, F.R.S., has been made a Knight Commander of the Bath. Dr. W. T. Prout, principal medical officer, colony of Sierra Leone, and Dr. J. W. Robertson, late Commissioner of Agriculture and Dairying of the Dominion of Canada, have been made C.M.G.'s. The

honour of Knight Bachelor has been conferred upon Dr. E. S. Stevenson, member of the medical council of the Cape of Good Hope; and Mr. Philip Watts, F.R.S., Director of Naval Construction, is made an ordinary member of the Civil Division of the Second Division, or Knight Commander, of the Order of the Bath.

A meeting of Members of Parliament, presided over by Mr. Haldane, met on Tuesday last in a committee room of the House of Commons to consider the question of a request for an additional State grant to the National Physical Laboratory. Dr. Glazebrook having made a statement as to the aims and needs of the laboratory, was followed by Mr. Chamberlain, who in the course of his remarks said that the real problem of the nation was how to improve our highest education. He felt convinced that if they were to speak of the whole matter as an investment, it was from higher education that they would gain the largest return. He asked in what way the National Physical Laboratory was distinct from other universities, such as those of Birmingham, Liverpool, Manchester, and Sheffield. He asked this because it was not merely the object of the universities to educate young persons; it was their object to carry on post-graduate research in the largest possible way—to make precisely the experiments which the laboratory was making. They did not want in any way to discourage that work in these separate universities; they did not want to centralise any branch of scientific work. He had himself rather a horror of central institutions, and he had a great belief in the freedom and the competition of a number of separate centres. He was sure that there was no idea of injurious competition in the minds of the promoters of the meeting; but he would like to be certain that it might not have that effect. After all, they were all more or less dependent, and they would be increasingly dependent, upon State aid, of which they had had very little up to the present. Were the universities, each of them, to apply separately and frighten the Treasury, or were they to put their forces together, and go as one body representing the whole and ask for a very largely increased grant, leaving it for consideration afterwards how that grant should be divided? Why were they making a special demand at that time for that particular institution? He was all in favour of giving assistance to any institution of the kind. But he should like to know in what way this was to be distinguished from the University of Liverpool or any of the others where they were carrying on the work of physical research. He would even ask why the promoters of this institution should operate alone—whether they would not do much more if they all came together. In that case they would, of course, have very much larger Parliamentary support. If each institution was to ask for what it wanted he was afraid the chances of success would not be great. He might be considered to be throwing cold water on the matter at the beginning, but as a fact he most entirely sympathised with the general object. He thought that such an institution was absolutely necessary, and if there were no others, then he would say most distinctly that it would have a special claim upon them. But as there were, and as they were all in their infancy, he wished to know in what way it was thought best to treat the matter when they approached the Government, whether as a whole on behalf of scientific instruction generally or whether on behalf of the claims of that particular institution. The chairman said they were all interested in what Mr. Chamberlain had said, and his suggestion of a collective movement in favour of the highest education. He thought the work that the National Physical Laboratory was doing could not be organised in connection with any of the universities. The following resolution was then put to the meeting and carried unanimously:—"That this meeting, being satisfied of the necessity of further State aid to the National Physical Laboratory, at Teddington, as regards both equipment and maintenance, requests the chairman and conveners of this meeting to prepare and present a memorial to the Chancellor of the Exchequer asking for such additional aid, and that the memorial be signed by members here present or who, being absent, may be in sympathy with its objects." Mr. Chamberlain, who had to leave before a decision was arrived at, said that if the meeting decided in favour of the resolution his name might be attached to it.

On Monday last Mr. Ailwyn Fellowes, President of the Board of Agriculture, was waited upon by a deputation from the Pharmaceutical Society respecting the proposed legislation to extend to other than chemists the right of selling poisonous products used in agriculture and horticulture. It was argued on behalf of the society that it would be dangerous to the public to allow any one to sell poisonous articles; that there was no difficulty in the way of farmers or horticulturists getting the articles through a chemist as cheaply as through any other person; and the public would be safeguarded by the special knowledge of the chemist and druggist. In reply, the President of the Board of Agriculture said he had received an enormous number of resolutions from all over the country in favour of a relaxation of the present law. The new regulations under the proposed Bill would provide:—(1) that no poisonous substance shall be kept in any shop or premises where articles of food are stored or kept for sale; (2) that poisons must be kept in a separate cupboard from other goods; (3) all poisons shall be sold in an enclosed vessel, labelled with the word "Poison"; (4) liquid poisons shall be sold only in bottles or tins easily distinguishable by touch from ordinary bottles or tins; (5) in granting licences the local authority shall have regard to the facilities already existing in the neighbourhood for the purchase of poisonous compounds.

According to the Berlin correspondent of the *Daily Chronicle*, Dr. Robert Koch has written from German East Africa stating that he has been studying the nature, habits, and anatomy of the tsetse fly, and that he has discovered a certain parasite in the fly to which he attributes the disease to which the cattle bitten by the fly succumb.

The death is announced, at the age of fifty-five years, of Prof. von Mikulicz-Radecki, of the University of Breslau, well known as a surgeon and for his numerous papers and memoirs on surgical subjects. About a year ago he delivered the Cavendish lecture before the West London Medico-chirurgical Society, and last year he was the president of the surgical section of the German Association of Men of Science and Medical Men.

The death is announced of Prof. P. T. Cleve, of Upsala, on June 18. He was born in 1840, and was the leading exponent of chemical research in Sweden. His hydrographical investigations were also of great importance. He was an honorary member of the Chemical Society.

The Barnard medal of Columbia University has just been awarded to Prof. H. Becquerel for "important discoveries in the field of radio-activity, and for his original discovery of the so-called dark rays from uranium, which discovery has been the basis of subsequent research into

the laws of radio-activity, and of our present knowledge of the same." The medal has been previously awarded to Lord Rayleigh, Sir William Ramsay, and Prof. Röntgen.

A PORTRAIT of Prof. W. Osler has been presented to the University of Pennsylvania by the members of the classes which from 1885 to 1891 studied under Prof. Osler when he occupied the chair of clinical medicine at the university.

A MEDAL has been struck to commemorate the successful completion of the Simplon Tunnel. On one side of the medal is a figure of Mercury and a locomotive emerging from the tunnel, with the inscription "Aux Collaborateurs et Ouvriérs du Percement du Simplon"; on the other is a representation of the meeting of the workmen when the last obstacle had been broken down, and bears the words "Souvenir de la Rencontre des Galeries, Fevr. 1905."

BUSTS of Joseph Lancaster and Michael Faraday—the gift of Mr. Passmore Edwards—were unveiled on Wednesday of last week in the entrance hall of the Borough Polytechnic Institute by Prof. Silvanus P. Thompson, F.R.S., who delivered an address.

To commemorate the anniversary of the one hundred and twenty-fifth birthday of Audubon, the American Museum of Natural History has placed on exhibition a collection of Audubon relics, among which is the portfolio in which Audubon carried specimen plates while securing subscribers to his great work, together with sketches and finished plates.

A SCHEME for the establishment of a Central Research Institute at Kasauli, and a laboratory for scientific, medical, and sanitary work at the headquarters of each provincial Indian Government, to provide more adequate means for the scientific study of etiology and the nature of the diseases of the country, has been published. It is hoped that when the project has been developed, not only will it be no longer necessary for officers to go to Europe to study the bacteriology and parasitology of tropical diseases, but that workers from England and the European Continent will avail themselves of the Indian laboratories and the unrivalled material for study which the diseases of the country afford. The scheme has the approval of the Secretary of State, and the Government of India proposes to appoint as the first director of the Central Research Institute Lieut.-Colonel Semple, M.D., well known for his work in connection with the Pasteur Institute of India.

A NEW society, to be known as the Harvey Society, has been established in New York under the patronage of the New York Academy of Medicine. Its purpose is the diffusion of scientific knowledge of anatomy, physiology, bacteriology, pathology, pharmacology, and physiological and pathological chemistry by public lectures given by men who are workers in the subjects presented. Each lecture is intended to represent the state of modern knowledge concerning the topic treated, and will be addressed to the general medical profession who are interested in the scientific side of medicine. The president is Dr. Graham Lusk. The members of the society consist of two classes, active and associate members. Active members are laboratory workers in the medical sciences residing in New York; associate members are such persons as may be in sympathy with the objects of the society, and reside in New York. The first course of lectures will be given at the Academy of Medicine on Saturday evenings during the winter of the years 1905–6.

A CONVERSAZIONE took place at King's College, London, on Thursday last, when many scientific and other exhibits were on view. An interesting item was a set of various forms of glow-lamps, a demonstration of which was given by Prof. E. Wilson in the Siemens electrical engineering laboratory, and which included mercury-vapour, Nernst, tantalum, and osmium lamps. There was also an exhibition of crystallisation shown on the screen by Prof. Herbert Jackson.

THE annual conversazione of the Institution of Electrical Engineers was held on June 29 at the British Museum (Natural History), South Kensington. It was attended by upwards of 1000 guests.

THE third International Electric Tramway and Railway Exhibition was opened at the Agricultural Hall, Islington, on Monday last by Lord Derby.

THE annual general meeting of the Society of Chemical Industry will begin in London on Monday next, June 10. The society numbers among its members some 1500 Americans, and at the last annual meeting, which, with special reference to the St. Louis Exhibition, was held in the United States, an American, Dr. W. H. Nichols, was elected president in succession to Sir William Ramsay. The American visit was a great success, and the British members of the society have looked forward to the time when they would be able to welcome in Great Britain their president and American and Canadian co-members. The proceedings in connection with the forthcoming meeting have therefore been specially arranged in view of this return visit. Dr. Nichols has already arrived in England, and we understand that the guests of the society will number in all about 120. A lengthy and interesting programme has been arranged.

THE sixty-fourth annual meeting of the Medico-psychological Association of Great Briain and Ireland will be held at 11 Chandos Street, Cavendish Square, on July 20 and 21 under the presidency of Dr. T. Outterson Wood. The annual dinner of the association is to take place on July 30 at the Whitehall Rooms.

THE American Anthropological Association is to meet in San Francisco, Cal., from August 29 to 31 next under the presidency of Prof. F. W. Putnam, when papers relating to ethnology, archæology, prehistoric man, physical anthropology, linguistics, and general anthropology will be read. The museum of the department of anthropology of the University of California at the affiliated colleges in San Francisco, which has recently been installed, but not yet opened to the public, will be the headquarters of the association.

A PRELIMINARY circular has been issued to announce that the tenth International Geological Conference will be held in 1906 in Mexico. An executive committee has been appointed, with M. José G. Aguilera, director of the National Geological Institute of Mexico, as president, and M. Ezequiel Ordóñez, assistant director of the same institution, general secretary. It is expected that the congress will open on September 6, 1906, and last for eight days.

THE Postmaster-General again directs attention to the fact that pathological specimens and articles of a similar nature may be forwarded only by registered letter post and in proper cases. The Post Office regulations provide that any deleterious liquid or substance sent by post must be enclosed in a receptacle hermetically sealed, which receptacle must itself be placed in a strong wooden, leathern,

or metal case, in such a way that it cannot shift about, and with a sufficient quantity of some absorbent material (such as sawdust or cotton wool) so packed about the receptacle as absolutely to prevent any possible leakage from the packet in the event of damage to the receptacle. The packet must also be marked "Fragile with care."

An exhibition of the results obtained last year by Prof. Flinders Petrie and his coadjutors in the field of Egyptian archæology was opened at University College, Gower Street, on Thursday last, and will remain on view for a month. Last winter excavations were carried on in the peninsula of Sinai. At Sarabit el Khadem the mines were of turquoise, and no copper was found. The interesting feature on this site is the evidence of the Semitic—not Egyptian—worship which was practised. The whole region is scattered over with shelters for pilgrims, usually containing a Bethel stone, some of which have Egyptian inscriptions of the twelfth dynasty. The pilgrims came for oracular dreams like Jacob's, and the shelters are only in the region of the temple. They are quite distinct from the miners' dwellings, such as are common at Wady Maghara. This Bethel custom is a special feature of Semitic belief, and is quite unknown in Egypt. The temple at Sarabit was originally a sacred cave—perhaps as early as Seneferu. It was carved by Amenemhat III., and furnished with altars for the worship of Hathor. In front of it, on the edge of the hill, was an enormous mass of ashes of burnt offerings, showing the burnt sacrifices on high places familiar to Semitic worship. The temple was extended over these burnt offerings by Tahutmes III. and other kings until Sety I. Of the temple itself a beautiful and instructive model is shown, the scale being one-fiftieth. The whole length of the building is nearly 250 feet. Though it has been known since the time of Niebuhr, no clearance had been made; but now many new features have been brought to light from under the rubbish. The primitive shrine of Hathor was a rock cave, and the discovery of a hawk with the finely cut name of Seneferu makes it probable that the shrine is as old as the third dynasty.

It is announced in the *Electrician* that as a result of the successful experiments with the De Forest wireless telegraphy in moving trains, the Chicago and Alton Railway will supply wireless telegraphy apparatus on its two express trains running daily between Chicago and St. Louis, and ultimately on its whole system. Messages were received while the train was running at fifty miles per hour. For some time while the train was approaching the Mississippi River above the elevated stretch leading to Merchants' Bridge, the increase in strength of the signals was very marked, but when the train entered the framework of the bridge it was found that signals became almost imperceptible owing to the screening action of the bridge. It was observed also that the signals were stronger when the train was broadside on to the transmitting station and running at right angles to it. The fact that the radiations were following the course of the river in preference to overland paths was very marked as the train pulled out of Alton, Illinois. At one point the track runs within a few hundred feet of the river, and at this point the signals from St. Louis, thirty miles away, which had just previously become very weak, were increased in intensity to a surprising degree. No difficulty seems to have been experienced even when the train was many miles from the transmitting station and was threading through the yards and sidings of Chicago, completely hidden by large elevators and steel structures of every description.

The New York correspondent of the *Lancet* states that a subcommittee of twenty-one coloured physicians and clergymen has been organised by the New York Charity Organisation Society's Committee on the Prevention of Tuberculosis to fight tuberculosis among the coloured people of New York. The New York health board is cooperating with the movement, and has placed its dispensary under the supervision of the medical members of the subcommittee for three evenings a week. A course of illustrated lectures treating of tuberculosis will be given shortly in the churches for coloured congregations. It is stated that there are between 60,000 and 65,000 coloured persons in New York city, and that their death-rate from tuberculosis is 5·33 per 1000, as against 2·37 per 1000 among the whites.

The first part of the Home Office "Mines and Quarries: General Report and Statistics for 1904" has just been issued. The total number of persons employed at the mines of the United Kingdom was 877,057, of whom 847,553 worked at the 3333 mines under the Coal Mines Act and 29,504 at the 673 mines under the Metalliferous Mines Act. The total number at coal mines is the highest recorded since 1873, and that at metalliferous mines the lowest. The output included 232,428,272 tons of coal, 3,043,045 tons of fireclay, 7,557,733 tons of ironstone, and 2,333,062 tons of oil shale. The coal production is the highest recorded. The deaths from accidents amounted to 1055 in collieries and 35 in metalliferous mines, the death rate per 1000 persons employed being 1·24 in the former case and 1·19 in the latter. It is gratifying to note that the former rate has never been lower.

No. 21 of the *Publications of the Earthquake Investigation Committee* (Tokyo) contains a lengthy paper by Prof. Omori on horizontal pendulum observations at Tokyo; the most interesting of the results is the conclusion that the first movement is usually towards the origin in the case of near or moderately distant earthquakes, but in a small proportion of the records it is away from the origin. The author attributes this difference to a distinction in the cause of the earthquakes, the first type being due to the sudden collapse of a subterranean cavity, or the crushing down of a horizontal stratum, and the second type to the sudden splitting asunder or widening of a vertical cavity by the expansive action of steam or gases. In another part of the paper, however, he points out that in the case of artificial earthquakes caused by explosions, the first movement is outwards if these take place on the surface of the ground, but inwards if the explosive is buried at some little depth. Other points which are commented on are the resemblance between the records of earthquakes of similar intensity and originating in the same region, and the occasional occurrence of long-period undulations combined with shorter-period vibrations in the first phase of distant earthquakes.

The investigations of the relation between variation of barometric pressure and sea level on the coast of Japan, which were noticed in Nature of November 3, 1904, has been continued by Prof. Omori, who shows, in the *Proceedings of the Tokyo Physicomathematical Society* (vol. ii., No. 20), that the relationship found on the Pacific extends to the western coasts of Japan, so that all round these islands the rise of sea-level is greater than that due to the local diminution of barometric pressure alone. The consequence of this is that a low barometer means a

decrease of pressure on land but an increase of pressure on the surrounding sea bottom, the latter being about 1·6 times as great as the former. An interesting result, attributed to this cause, is given in No. 21 of the *Publications of the Earthquake Investigation Committee*, where the behaviour of a horizontal pendulum during the storm of October 10–11, 1904, is described; the low-pressure area passed to the east of Tokyo, and during its passage the horizontal pendulum indicated a tilting, which reached 3·5 seconds of arc, to the east—that is, in the direction of the low barometric pressure—indicating an increase of pressure on the sea bottom in that direction.

WE have received the report of the Government Observatory, Bombay, for the year 1904. This observatory deals chiefly with terrestrial magnetism, meteorology, and seismology; it has issued a long series of valuable publications, and many years ago Mr. Charles Chambers, then director, prepared an elaborate discussion of the meteorology of Bombay. The care bestowed upon the records of the photographic self-registering instruments may be gathered from the fact that the watchmen go round once every hour, night and day, to see that the clocks are all going and the lights burning. Their regular attendance is automatically recorded on the photograms themselves. The total rainfall for the year amounted to only 33·4 inches, being 41·7 inches below the normal value for twenty-four years (1873–96); this is the smallest fall recorded at the observatory. Milne's seismograph registered thirty-five earthquakes during the year.

FROM information received from the president of the International Aëronautical Committee, we find that in the months of January to April last the average monthly number of stations participating in the balloon and kite ascents was sixteen; kite observations were made each month at Oxshott by Mr. Dines, and at Aldershot, by the military balloon section, in February and March. The most notable heights attained, by means of unmanned balloons, were 19,420 metres at Strassburg and 21,733 metres at Berlin. In April kite and unmanned balloon observations were made from the Prince of Monaco's yacht in the Mediterranean. These are the first ascents made with unmanned balloons in the open sea, and these successful experiments show that Prof. Hergesell's idea of obtaining such observations over the oceans may possibly be realised.

BULLETIN No. 35 of the Storrs Agricultural Experiment Station, Conn., deals with the Camembert type of soft cheese. The conclusion is arrived at that the ripening is due to definite moulds and bacteria. One mould (? *Penicillium candidum*) seems to produce the changes which result in the texture of the cheese, and it, together with the *Oidium lactis*, produces the flavour, lactic acid bacteria giving the necessary acidity and retarding the action of other bacteria. It is found possible so to control the process of ripening that the desired result may be obtained with reasonable uniformity.

WE have received the first number of a new periodical, the *Medico-technologisches Journal*, edited by Dr. Berthold Beer, which is to be devoted to medical and surgical instruments and the various apparatus employed in bacteriology, photography, radiography, hygiene, &c., and appertaining to the medical sciences and physical therapeutics. It contains a prefatory article by Dr. Beer, and descriptions of Zeiss's apparatus for the demonstration of ultra-microscopic particles and of various surgical instruments and pharmaceutical preparations, together with photographic and balneological notes and new literature. Such a journal, provided it gives concise descriptions of the principal new inventions of the various countries, and not of Germany only, should supply a decided want.

IN a paper contributed to the June number of the *Zoologist* Mr. J. G. Millais points out that the English black rat—the type of *Mus rattus* of Linnæus—is by no means the blackest representative of the species, that distinction falling to a race which it is proposed to call *M. rattus ater*, and of which specimens have been taken in England. No doubt this is right enough, but when the author proceeds to suggest English names for the various local races of the species in question he follows a course which, in our opinion, cannot but land him in difficulties. The species itself he rightly calls the black rat, but for its local races the name of Alexandrine rat is taken, so that the typical form becomes the northern Alexandrine rat, while the new race is termed the black Alexandrine rat. Their proper designations should be the Alexandrine black rat and the Black Sea black rat.

IN the *Transactions of the Royal Society of Edinburgh* (vol. iii., part iii., No. 22) Sir Charles Elliot describes the nudibranch molluscs collected during the Scottish National Antarctic Expedition. These comprise but two species, two of which are, however, referable to new and interesting generic types. The most remarkable feature is the absence in the collection of all representatives of Doris and its allies, a feature common to the *Discovery* collection of this group, which has been entrusted to the author for description. Certain holothurians of the genus Psolus from the Antarctic present a superficial resemblance to dorids, although this is not regarded as more than accidental.

As a supplement to part iii. of Prof. Herdman's report on the pearl oyster fisheries of the Gulf of Manaar, published by the Royal Society, Messrs. Shipley and Hornell describe several new parasitic worms (some referred to new generic types) obtained from elasmobranch fishes frequenting the pearl-banks. Possibly, although not probably, some of the cestodes may be the parent form of the pearl-producing larvæ. No direct light is thrown by the investigations on the problem of the *provenance* of the pearl-producing parasite.

THE departmental committee appointed to investigate certain matters connected with the sea-fisheries of Sutherland and Caithness reports that cod and ling have of late years been much less abundant than formerly on the coast. As regards a proposed close time for herrings, it was considered that the fishermen themselves are the best judges as to whether such a protective measure is advisable. Trawling in the Moray Forth (which is not permitted to British craft) by foreign vessels is held to be responsible for considerable injury to the fishery.

ACCORDING to the report for 1904, the Marine Biological Association of the West of Scotland has had a very successful year, the only drawback being certain difficulties with regard to the staff. The year witnessed the practical completion of the large extensions of the station generously provided by Mr. J. Coats, jun., which were opened by Sir John Primrose in September last, and promise to meet all present requirements. The hope is expressed that it may be found possible to retain the invaluable services of the S.Y. *Mermaid* during the present season.

Nos. 4 and 5 of the admirable series of Cold Spring Harbour Monographs are respectively devoted to the life-history of the chrysomelid beetle *Chlamys plicata*, commonly called "case-bearer," and of the "mud-snail" (dog-whelk), *Nassa plicata*, E. M. Briggs and A. C. Dimon being the respective authors, or, as some would say, authoresses. The case-bearer is remarkable for the fact that its encased larvæ resemble not only undeveloped buds of the alder, but likewise the fruit of the high-vine blackberry. Of the "mud-snail" the life-history and habits are described in considerable detail, and a number of observations recorded with regard to its reactions to light, &c.

Two addresses, on "Spirals" and "Ambidexterity," which were delivered before the Hampstead Scientific Society by Sir Samuel Wilks, Bart., F.R.S., on April 14 and May 12 respectively, have just been issued in pamphlet form by Mr. S. C. Mayle, of Hampstead. The society is to be congratulated on having the active support of so eminent a man as Sir Samuel Wilks.

At the meeting of the Aëronautical Society of Great Britain to be held on Wednesday next, the following communications will be read:—"Some Remarks on Aërial Flight," by G. H. Wenham; "Demonstration of a Bird-like Flying Machine," by Dr. F. W. A. Hutchinson; "Balloon Varnishes and their Defects," by W. F. Reid; and "The Thrust of Aërial Propellers," by W. G. Walker.

OUR ASTRONOMICAL COLUMN.

Observations of the Satellites of Saturn and Uranus.—An important set of observations of the satellites of Saturn and Uranus, involving some hundreds of individual "settings," was made by Messrs. Frederick and Hammond with the 26-inch equatorial of the U.S. Naval Observatory during 1904. The position angle and distance of each satellite were measured from a second satellite, the angle about the inner body always being taken. The observations extended over the period May 24 to October 11, and the detailed results are published in No. 4026 of the *Astronomische Nachrichten*.

Geodetic Measurements from Solar Eclipses.—The *Journal of the British Astronomical Association* (vol. xv., June 22) contains a paper in which Mr. C. E. Stromeyer points out that if the central shadow of the coming August eclipse be accurately located, all the necessary data will be available for the determination of the geocentric difference of any two observation stations. He proposes two methods for eye observations, and two photographic methods, of which one in particular seems capable of being carried out with the desired precision; it consists in photographing a trail of the central phase of the eclipse on to a moving film.

The method described can be carried out both within and outside the shadow, but the best results will be obtained if the observer is just on the edge of the shadow. The method can also be used with annular eclipses, and if found to be trustworthy would be a valuable means for gradually determining the geocentric distances of various points, even of islands in mid-ocean, which can never be triangulated.

Monochromatic Photographs of the Orion Nebula.—On obtaining a series of spectrograms of the Orion nebula with a small objective-prism quartz spectrograph, Prof. Hartmann found that different parts of the nebula emit light of very different composition, whilst large areas, of characteristic forms, shine solely by the ultra-violet radiation at λ 3727. This variety of the light emitted by the several areas of the nebula led Prof. Hartmann to employ colour screens in obtaining direct photographs with a Steinheil reflector of 24 cm. aperture and 90 cm. focal length. Three screens were used; the first completely absorbed all wave-lengths shorter than λ 4800, but allowed Hβ and the two chief nebular lines, N_1 and N_2, to pass through almost without any diminution of intensity. The second screen freely transmitted all radiations between λ 3880 and λ 3740, but absorbed all others, whilst with the third the absorption commenced at λ 5050, increased rapidly to totality at Hβ, extended to λ 4000, and then quickly decreased until at λ 3727 the transparency was very nearly complete. In this screen the two chief nebular lines were faintly transmitted, but it was an easy matter to eliminate their action by employing a plate of suitable sensitiveness. Combining the first and third screens cut out Hβ, leaving only N_1 and N_2 effective.

Marked differences of the intensities of several areas, as shown on the various photographs obtained with different screens, are plainly seen on the reproductions accompanying Prof. Hartmann's paper. Evidently the radiation λ 3727 is extraordinarily intense in *all* parts of the nebula, whilst in some parts it is almost the sole radiation, producing strong photographic images where the eye sees nothing. The nebula G.C. 1180 surrounding the star *c* Orionis is scarcely visible on the N_1 and N_2 photograph, but it is a prominent feature on that obtained with the ultra-violet light, and is fairly bright on the Hβ plate.

This differential action suggests to Prof. Hartmann the presence of at least *three* gases in the Orion nebula, one of which emits the chief nebular radiations, the second hydrogen, and a third, which emits the radiation at λ 3727 (*Astrophysical Journal*, No. 5, vol. xxi.).

Periodicity of Aërolite Falls.—Among a number of interesting papers published by the Royal Astronomical Society of Canada ("Selected Papers and Proceedings," 1904) we notice one by Mr. W. H. S. Monck in which the author suggests that aërolites, like meteors, effect a certain periodicity. He first shows that the months of May and June stand out prominently in his catalogue of aërolites as the two months of the year in which a greater proportion of known falls have taken place. The number per diem for these two months is 1·34, whilst for the rest of the year it is only 0·81.

In an argument supporting the suggested periodical relation between various aërolite falls, Mr. Monck cites instances in which (1) aërolites fell within one or two days of each other in the same year; (2) aërolites fell on almost the same date in two consecutive years; (3) aërolites fell on nearly the same date after an interval of two or three years; and the number of cases quoted seems to place the matter beyond one of chance coincidences. Further, an analysis of the catalogue dates and numbers indicates a marked tendency for series of falls to congregate about certain dates, and for these falls Mr. Monck tentatively deduces periodicities varying from seven to twenty years.

The Reality of Supposed Changes on the Moon's Surface.—In a paper published in the June number of the *Bulletin de la Société astronomique de France* M. Puiseux discusses at some length the various observations of alleged changes on the lunar surface under the influence of the solar radiation. Going back to the earliest observations of details, he carefully considers each authoritative report of suspected change up to the most recent observations of the reported increase of the diameter of Linné during lunar eclipses. Summing up all the evidence thus examined, M. Puiseux arrives at the conclusion that the case for real changes taking place on the surface of our satellite is not established. He believes that the change of sensitiveness of the retina when observing faint objects is sufficient to account for the changes visually observed, whilst the different conditions of exposure when photographing the eclipsed moon might easily introduce the changes suspected from the examination of photographs.

The Circumzenithal Apparatus.—A new circumzenithal apparatus, devised by MM. Nušl and Frič for the determination of latitude, &c., was briefly described in these columns for August 20, 1903. A full and illustrated description of the instrument, and of the various improvements suggested by experience in its use, is now given in the Bulletin International of the Académie des Sciences de François Joseph I. (Prague, 1904) by the inventors, together with a detailed account of the observations already made and the methods employed in reducing the same.

THE NEEDS OF OUR OLDEST UNIVERSITY.

THE following statement has been drawn up by those professors and heads of departments of the University of Oxford whose names are appended, each being responsible for the details of his own and allied subjects, but expressing also a general sympathy with the scheme as a whole. It indicates the cost at which, in their opinion, all important existing deficiencies (except those of law) may be met by a generous provision for research as well as for teaching.

To carry out the scheme here set forth would require a capital outlay of about 564,000*l.*, and an annual income of about 93,000*l.*

A large proportion of the capital sum proposed for building the new laboratories, together with the whole sum proposed for the purchase of land near the museum, might be saved if the chemical and physical departments were moved from their present position. It is estimated that at a cost of about 60,000*l.* all existing or proposed departments in these branches of science could be accommodated, and space found for other proposed laboratories in the buildings thus set free.

With the sums hereafter named, in addition to her present resources, Oxford could successfully meet every pressing need as well as those demands which it is believed will pour in from many parts of the Empire, from the United States, and from Germany.

The present occasion has been thought a favourable one for stating clearly the full cost which, in the opinion of those who have signed this document, would enable Oxford confidently and hopefully to face the great responsibilities which have been placed upon her. But whatever be the outcome, her professors and heads of departments gladly welcome the inspiring opportunity for research and for education which these new responsibilities will assuredly bring. They will cheerfully attempt to meet the coming needs, even with the present inadequate resources, but they consider it right to point out that their work will be done under the greatest difficulties and therefore inadequately.

The insufficient endowment of many university departments and the necessity for further equipment have been subjects of anxious consideration for many years, culminating in the Vice-Chancellor's letter of February 20, 1902, to heads of institutions and departments—published with the answers in the "Statement of the Needs of the University" (Oxford, 1902). The estimates of expenditure given below have been largely based upon these published replies to a letter which was issued before our necessities became still more pressing in consequence of the will of Mr. Rhodes. Many additional needs not contemplated in the replies to the Vice-Chancellor have also come to light in the course of this inquiry, and are provided for in the following scheme. The published statement of needs is itself introduced by the following sentence (p. 3): "It is hardly necessary to add that in dealing with prospective needs it is generally impossible to form even an approximate estimate of the new and ever-increasing wants which the rapidly-growing requirements of our time may bring, and indeed in some instances (even since these statements were prepared) have already brought within view."

It has been assumed in the following statement that every important university chair, including all those to which the care of a department providing for one of the chief scientific subjects is attached, should be of the value of 900*l.* a year. In fixing this sum the traditions of the last Commission have been followed, but it is necessary to bear in mind that the growth of universities in the future and the competition between them may ultimately render such a sum insufficient to attract and retain the greatest workers and teachers. Under existing conditions we are convinced that it is adequate, but the university would require a large increase of income before she could provide for every important chair the stipend with which it is sometimes erroneously believed to be endowed.

Each new laboratory devoted to one of the principal branches of natural science has been estimated to cost 30,000*l.*, exclusive of site. It is believed that this sum would provide fittings and sufficient apparatus to begin teaching and research on an adequate scale, allowance being made for the material now in the possession of the university. It has been assumed that every important laboratory, both new and old, should receive an income of 3000*l.* a year, for professor's stipend, demonstrators, assistants, apparatus, and material for research and for teaching, and the general expenses of maintenance.

With such an income a professor could encourage several of his most promising men to do original work, giving them employment in teaching or working for the department during a part of their time.

Attention to the large and insistent needs of the existing and proposed scientific departments has been accompanied by a generous provision for the necessities of other subjects, and especially by the suggested increase of the Bodleian income to 23,000*l.* a year—even then less than one-third of the annual sum supplied to the National Library.

We feel that it is not too much to claim that the annual output in research and teaching from the small inadequately endowed—often miserably endowed—departments of the university, justifies the confident conclusion that a liberal provision for existing and imminent needs would be followed by results of the highest importance to the Empire as well as to the university. The results would be threefold—the advancement of learning, which is the highest and noblest function of a university; the adequate teaching of many subjects of the first importance, now imperfectly provided, or not provided at all; the inestimable benefits conferred upon students by living in an atmosphere of research.

H. B. Baker, F.R.S., Lee's reader in chemistry; Henry Balfour, curator of the Pitt-Rivers Museum; R. E. Baynes, Lee's reader in physics; T. K. Cheyne, Oriel professor of the interpretation of Holy Scripture; R. B. Clifton, F.R.S., professor of experimental philosophy; S. R. Driver, Regius professor of Hebrew; F. Y. Edgeworth, professor of political economy; E. B. Elliott, F.R.S., Waynflete professor of pure mathematics; Robinson Ellis, Corpus professor of Latin literature; W. Esson, F.R.S., Savilian professor of geometry; Arthur J. Evans, F.R.S., keeper of the Ashmolean Museum; C. H. Firth, Regius professor of modern history; P. Gardner, Lincoln and Merton professor of archæology; Francis Gotch, F.R.S., Waynflete professor of physiology; H. Goudy, Regius professor of civil law; F. Ll. Griffith, reader in Egyptology; W. Lock, Ireland professor of exegesis of Holy Scripture; A. E. H. Love, F.R.S., Sedleian professor of natural philosophy; R. W. Macan, university reader in ancient history; A. A. Macdonell, Boden professor of Sanskrit; D. S. Margoliouth, Laudian professor of Arabic; Henry A. Miers, F.R.S., professor of mineralogy; W. R. Morfill, professor of Russian; A. S. Napier, Merton professor of English language and literature; E. W. B. Nicholson, Bodley's librarian; W. Odling, F.R.S., Waynflete professor of chemistry; R. L. Ottley, Regius professor of pastoral theology; H. F. Pelham, Camden professor of ancient history; E. B. Poulton, F.R.S., Hope professor of zoology; Arthur Sidgwick, university reader in Greek; W. A. Raleigh, professor of English literature; John Rhys, Jesus professor of Celtic; James Ritchie, reader in pathology; W. Sanday, Margaret professor of divinity; A. H. Sayce, professor of Assyriology; Henry Sweet, university reader in phonetics; W. J. Sollas, F.R.S., professor of geology; John S. Townsend, F.R.S., Wykeham professor of physics; H. H. Turner, F.R.S., Savilian professor of astronomy; E. B. Tylor, F.R.S., professor of anthropology; Sydney H. Vines, F.R.S., Sherardian professor of botany; W. F. R. Weldon, F.R.S., Linacre professor of comparative anatomy; Joseph Wright, professor of comparative philology.

The late Regius professor of medicine, Sir John Burdon Sanderson, F.R.S., has expressed his approval.

Bodleian Library.—Fire-proofing, additional storage, additional reading-room, warming picture-gallery, electric lighting of camera (see also Central University Institution below, which it is suggested might liberate additional space for the Bodleian) (25,000*l.* : —); large increase of staff, filling up deficiencies in and maintaining special departments, printing the catalogue, binding (including arrears) (— : 13,000*l.*).

In this and all other cases the sum placed before the colon indicates capital outlay, that placed after the colon annual expenditure.

Central University Institution.—Containing workrooms and lecture-rooms for professors not otherwise provided for, university chest, delegates' rooms, committee rooms, &c.,

&c. The Clarendon building might be incorporated in Bodleian (cost, including site in a central position, 80,000*l.* :—); custody of same, warming, lighting, cleaning (— : 400*l.*); stipend of librarian for departmental libraries (— : 200*l.*).

Examination Schools.—Installation of the electric light (1000*l.* :—).

Theology.—Oriel professor of interpretation of Holy Scripture, stipend (the chair to be detached from the canonry at Rochester) (— : 900*l.*); Dean Ireland's professor, increase of stipend (— : 500*l.*); two additional professors, ecclesiastical history (— : 900*l.*), Christian archæology (— : 600*l.*); four additional readers (300*l.* each), ecclesiastical history, liturgiology, Rabbinical Hebrew, Biblical archæology (— : 1200*l.*); Grinfield lecturer on Biblical Greek, increase of stipend, making the lectureship equal to a readership, with reader's duties (— : 230*l.*); [additional readers (not exclusively concerned with theology)—Aramaic, Armenian, Coptic, Ethiopic] (— : 1200*l.*); travelling fellowships (2) (— : 400*l.*); capital fund from which payment might be made for occasional lectures (3000*l.* : —).

Greek, New Professor of Mediaeval and Modern Greek.—Stipend (— : 900*l.*).

Classical Palaeography.—Stipends of new readers, Greek and Latin (300*l.* each) (— : 600*l.*).

New chairs of Pali and Persian philology and literature (700*l.* each) (— : 1400*l.*).

Reader in Prakrit Philology and Literature.—Stipend (— : 300*l.*); increased stipend of 100*l.* to each of the five teachers of Indian vernacular, and additional grant to Indian Institute for purchase and care of Indian antiquities, &c. (300*l.*) (— : 800*l.*).

Ashmolean Museum.—Extension of site, increase of museum, cases and fittings, including a numismatic department and space for growth of the departments mentioned below (30,000*l.* : —); increased staff both for the museum and common service of the Ashmolean museum and university picture-gallery, and stipend of librarian (— : 1000*l.*); post-graduate studentship in archæology, art, &c. (— : 1000*l.*); purchase of specimens, books, &c. (— : 1500*l.*).

Classical Archaeology.—Increased stipend of chair, three new readerships (— : 1500*l.*).

Increase required for creation of new chairs of *Greek and Roman Epigraphy and Inscriptions* (700*l.* each), *Egyptology* (700*l.*), *Assyriology* (700*l.*), *History of Religions* (700*l.*), *Northern Archaeology* (900*l.*), *History of Architecture* (900*l.*) (— : 5300*l.*)

University Picture Gallery.—Extension of site, increase of gallery (10,000*l.* : —).

Slade Professor of Fine Art.—Increased stipend for resident chair, wages of attendant (— : 600*l.*); increase of stipends, purchases, &c. (— : 1000*l.*).

Pitt-Rivers Museum (Ethnology).—Increased space, building (8000*l.*), cases and fittings (4000*l.*), electric lighting (250*l.*), (12,250*l.* :—); increase of stipend, a professorship of anthropology might, at some future time, be combined with the curatorship (— : 700*l.*); assistants, service, general expenses and purchase of specimens (— : 700*l.*).

Astronomy, Savilian.—Building and apparatus (10,000*l.* : —); annual grant to make up a moderately efficient and well-equipped observatory with an income of 5000*l.* (— : 3500*l.*).

Increase required for creation of new chairs in scientific subjects and the building and new laboratories, &c. Under each chair the first-named sum represents capital expenditure for a new building, or for adapting an existing structure; the second sum represents the annual expenditure for the stipend of the chair, provision of demonstrators and assistants, the expenses of research and of service and maintenance:

Engineering (30,000*l.* : 3000*l.*); *Organic Chemistry* (30,000*l.* : 3000*l.*); *Physiological and Applied Botany* (20,000*l.* : 2000*l.*); *Biochemistry* (12,000*l* : 2000*l.*); *Experimental Psychology* (15,000*l.* : 2000*l.*); *Pathology* (— : 1500*l.*, allowing for existing readership); *Pharmacology and Materia Medica* (15,000*l.* : 1500*l.*, allowing for existing lectureship); *State Medicine and Hygiene* (10,000*l.* : 2000*l.*). The Regius professorship of medicine might perhaps be combined with one of the suggested new chairs of medicine.

Increase required for building new or adapting old laboratories and other capital expenditure, for existing chairs in scientific subjects, &c., for increase of the stipend of the chairs, for additional demonstrators and assistants, and for the expenses of research and of service and maintenance. The capital expenditure is placed first, the annual second, under each chair:

Experimental Philosophy, Clarendon.—*Light and Sound* (25,000*l.*, to include provision for elementary students and for examinations : 2000*l.*); *Electricity and Magnetism,* Wykeham (30,000*l.* : 2000*l.*); *Heat,* Lee's (30,000*l.* : 2000*l.*, allowing for Lee's readership); *Inorganic Chemistry,* Waynflete (30,000*l.*, old laboratory for extension of mineralogy, geology, and the Radcliffe library : 2200*l.*); *Physical Chemistry,* Lee's (30,000*l.* : 2000*l.*, allowing for Lee's readership); *Mineralogy,* Waynflete (15,000*l.* : 2200*l.*, including an assistant chair of metallurgy); *Geology* (20,000*l.* : 3000*l.*, including two assistant chairs); *Comparative Anatomy,* Linacre (— : 1000*l.*); *Zoology,* Hope (7000*l.*, chiefly for cabinets (— : 2500*l.*, including the maintenance of a tropical biological laboratory); *Systematic Botany,* Sherardian (— : 1000*l.*); *Animal Physiology,* Waynflete (6000*l.* : 1000*l.*); *Human Anatomy* (— : 1000*l.*).

Secretary of the Museum Delegates and of the Scientific Departments.—Increase of staff for the general purposes of the museum and to enable the secretary to collect all fees of the scientific departments (— : 400*l.*).

Sites for Scientific Departments.—For purchase of land in the neighbourhood of the present museum (50,000*l.* : —).

Geography.—Stipend of new chair (— : 700*l.*); assistant lecturers (— : 750*l.*).

University Chest.—Increased income to meet expenses in connection with additional buildings (— : 2000*l.*).

Modern History.—New chairs of economic history, colonial history, and military history (900*l.* each) (— : 2700*l.*); "seminars," maintenance and equipment of (100*l.* for each of the chairs) (— : 500*l.*); Lectureships—additional payment of existing lecturers and appointment of new lecturers, class expenses (— : 1500*l.*).

Political Economy.—Increased stipend of chair (200*l.*), see also the new chair of economic history proposed under Modern History; lecturers in economic theory, in statistics and applied economics, and in economic geography (200*l.* each); expenditure on examinations, &c. (50*l.*); secretary and clerk (150*l.*), (— : 1000*l.*).

English Language.—Two assistants in English language (— : 600*l.*).

English Literature.—Increased stipend of chair (400*l.*); two assistant lecturers in English literature (150*l.* each); one reader in rhetoric and criticism (300*l.*) (— : 1000*l.*).

Modern Languages.—Increase of stipends of Taylorian teachers to 600*l.* each (— : 1600*l.*); assistant lecturers (— : 1000*l.*).

New Chair of Phonetics.—Stipend (— : 900*l.*).

Total (546,250*l.* : 93,880*l.*).

PRELIMINARY REPORT OF THE DEPARTMENTAL COMMITTEE ON THE ROYAL COLLEGE OF SCIENCE AND ROYAL SCHOOL OF MINES.

TO THE MOST HONOURABLE THE MARQUESS OF LONDONDERRY, K.G., PRESIDENT OF THE BOARD OF EDUCATION.

MY LORD MARQUESS,

We, the Departmental Committee appointed by Your Lordship in April last to inquire into the present and future working of the Royal College of Science (including the Royal School of Mines), and into questions connected therewith, have the honour to submit a Preliminary Report.

I. In conducting the inquiry referred to us, we have held 17 meetings, at which we have examined 21 witnesses, the remainder of the time having been devoted to consideration of the information thus supplied to us. The evidence which we have received has been largely concerned with the history of the Royal College of Science (including the Royal School of Mines), with the character of the instruction now given therein, and with the possibility of attracting students more advanced in their education than the majority of those who now seek admission. On this branch of our inquiry we should be prepared to submit recommendations which we think would conduce

to increase the great usefulness of these institutions, even though conducted in the main upon their present lines; but we have thought it desirable to defer making such recommendations at the present time for reasons which we will now proceed to state.

II. It will be remembered that the terms of reference to the committee were as follows:—" To inquire into the present working of the Royal College of Science including the School of Mines: to consider in what manner the staff, together with the buildings and appliances now in occupation or in course of construction, may be utilised to the fullest extent for the promotion of higher scientific studies in connection with the work of existing or projected Institutions for instruction of the same character in the Metropolis or elsewhere: and to report on any changes which may be desirable in order to carry out such recommendations as they may make."

We recognise the admirable work accomplished by the Royal College of Science not only in training teachers, but in its general method of science teaching and in the promotion of research. Notwithstanding the marked increase in the number of institutions where teachers of science can be trained, the demand has also so increased that the need for teachers of science who have been well trained in scientific method is no less now than when the college was established as a normal school of science. At the same time it is agreed that there is an urgent national necessity for increased facilities for advanced instruction and research in science, especially in its application to industry. In view of this fact, and in view of certain munificent offers of aid towards the provision of such facilities in London, we have felt that it was necessary, in order to discharge the reference to us, to survey the resources available for, and the potentialities of, the principal existing and projected institutions of the character contemplated in our terms of reference. We have now proceeded far enough in this survey to satisfy ourselves that the moment is *primâ facie* opportune for a comprehensive scheme. The accomplishment, however, of such a scheme as we have in mind can only be brought about by the realisation of the offers of aid which are referred to above, and by the cooperation of certain influential bodies possessing an interest in such institutions as are dealt with in our proposals.

It has, therefore, become necessary for us to approach these bodies and the persons who have made these munificent offers. But before we proceed any further in this direction, we feel that our position would be strengthened if we could be assured that our proposals will meet with the approval of the Government, and we have accordingly decided, in view of the stage at which we have arrived, to present this preliminary report, in which we outline the scheme we think desirable, and specify the conditions which in our opinion would make it possible.

III. The conditions which, if fulfilled, would, in our opinion, ensure the success of the scheme are:—(1) The gift of a large capital sum (say not less than 100,000*l.*) for buildings and initial equipment.

(2) The gift of a considerable additional site (say not less than 4 acres) at South Kensington.

(3) The willingness of the Board of Education to allow their college at South Kensington to be brought into a scheme of common government and administration.

(4) The similar willingness of the City and Guilds of London Institute in respect of their college at South Kensington.

(5) The continuance of the Government contribution including the necessary provision for the maintenance of the new laboratories and other buildings of the Royal College of Science, now approaching completion.

(6) The continuance of the support given by the Corporation and Livery Companies of the City of London to the Central Technical College.

(7) The provision (in the proposed College of Applied Science at South Kensington) of instruction in certain departments of engineering either by new foundation or by transfer and enlargement of part of the work of some existing college or colleges (*e.g.* University College or King's College).

(8) The cooperation of the University of London.

(9) The assurance of a sufficient maintenance fund.[1]

IV. Given the fulfilment of the above conditions, we should be prepared to recommend such a scheme as is indicated in outline in the following paragraphs:—

(1) In considering the problem laid before us by the Government, we are impressed by the fact that the most urgent need in scientific education is the establishment of a centre in which the specialisation of the various branches of study and the equipment for the most advanced training and research should be such as ultimately to make it the chief technical school of the Empire.

So large a scheme cannot be carried out in a day, but we believe that the present is a favourable opportunity for making a beginning, and in the suggestions which follow we have kept the above end steadily in view. The existence of the Royal College of Science with the Royal School of Mines and of the Central Technical College in close proximity points to South Kensington as the best position for such a centre as we contemplate; and we have made careful inquiry as to the extent of the accommodation which is at present concentrated in that neighbourhood. It is as follows:—(*a*) Accommodation for about 200 students in the permanent part of the existing buildings of the Royal College of Science and the Royal School of Mines. (*b*) Accommodation for from 300 to 350 students including accommodation for work for about 100 advanced students in the physics and chemistry laboratories in the Royal College of Science, now approaching completion. (*c*) Accommodation for about 300 students in the existing buildings of the Central Technical College.

With the exception of the new laboratories of the Royal College of Science, these buildings are fully occupied by students, but the accommodation for mining and metallurgy is quite inadequate, and is to a great extent merely temporary. Further, the accommodation for engineering, whether in the Royal School of Mines or in the Central Technical College, is insufficient to meet the wants of many qualified students who are annually refused admission for want of space, and in no branch of applied science is sufficient provision made for advanced or specialised work.

There is no doubt that if arrangements could be made between the Government on the one hand and the City and Guilds of London Institute on the other, the resources of the above mentioned institutions could be used with far greater effect and economy.

(2) The buildings and equipment, even if such arrangement were made, though in many respects excellent and extensive, are quite inadequate for existing requirements, and still more for the purpose in view. The provision to be made for the future should include not only a fully developed School of Mining and Metallurgy and departments for the principal branches of engineering, but also for other special subjects.

We do not attempt in this Preliminary Report to draw up a detailed scheme, but the following principal subjects should be within the purview of the institution:—

As preparatory subjects—mathematics, physics, chemistry and geology. Under the general heading of civil engineering—works of construction, mechanical engineering, electrical engineering, mining engineering, marine engineering and naval architecture. Some branches of chemical technology, and certainly metallurgy.

As illustrations of the kind of higher or more specialised application of these subjects, some of which we suggest should be dealt with, we need only mention the applications of engineering to railway, dock, and hydraulic work; the development of electricity in the direction of electric traction, lighting and telegraphy, and electrochemistry. It would be impossible to provide for the whole of the above subjects at once. Some of the more specialised subjects, such as the advanced metallurgy of

[1] For such a maintenance fund we look to the following sources in addition to those mentioned above under headings 5 and 6.

(*a*) Any grant from the vote for university colleges to which the institution may be able to establish its claim.

(*b*) An annual grant from the London County Council.

(*c*) The Bessemer Memorial Fund (so far as not applied to capita expenditure).

(*d*) Fees of students.

(*e*) Endowment of special forms of instruction given by persons or bodies interested.

(*f*) Any portion of funds given for capital purposes which may remain available for income after the necessary capital expenditure.

iron and steel, and certain branches of manufacturing chemistry, would probably be better dealt with in institutions which are, or may be, established in the provinces. Even, however, if the scheme be restricted by the exclusion of such subjects, its realisation would require at least the whole of the site still available at South Kensington, and great advantage would be obtained by grouping the first extensions immediately round the nucleus provided by the Royal College of Science and Central Technical College.

We believe, however, that if the various London institutions concerned were willing to cooperate fully in the matter, and proper arrangements were made for coordination of the considerable resources already existing, the necessary special departments might be established early.

It is quite compatible with an effective realisation of the scheme that separate departments might be conducted in detached colleges.

In view of the terms of reference, we have given special consideration to the provision required for higher education in mining and metallurgy, and we are satisfied that the maintenance of a fully equipped Central School of Mines is desirable. While facilities for advanced instruction in coal mining and in the mining and metallurgy of iron are now available in some of the larger centres of those industries, it is important that there should be a central school affording a full course of instruction in the mining and metallurgy of metals produced in India and the Colonies, but not found, or not found in large quantity, within the United Kingdom. As London is the financial centre of many great engineering, mining, and metallurgical industries in the Colonies, it is in the opinion of several witnesses the best site for a more highly developed School of Mines which shall provide for the needs of the Empire. It has been proved to us that the number of Englishmen who rise to important posts in connection with the mining industries of India, Australia, and South Africa is less than is desirable.

We have, for the present, deferred consideration of the biological department of the Royal College of Science.

(3) We consider that the advantages of the higher technical courses, which we contemplate at South Kensington, should only be available for students who can pass a satisfactory test for admission thereto. The preliminary science and such rudiments of engineering as may be prescribed for candidates before entering on these higher courses might be obtained either in the laboratories of the Royal College of Science and Central Technical College, or elsewhere in London or the provinces. Admission to these higher courses should be restricted to duly qualified students who, it is hoped, would be attracted from all parts of the Empire.

(4) We think it is important that the interests both of pure and applied science should be adequately represented on the body which administers the new institution. It is of the first importance that there should be no divorce between teaching and research in technology on the one hand and in pure science on the other, and we therefore regard it as an advantage that ample provision has already been made by the Government for the teaching of certain sciences on a site which we hope may be connected even more closely than at present with the highest and most specialised branches of technology. With regard to both subjects, we believe that it may be necessary hereafter to limit the instruction to the higher branches of both pure and applied science.

(5) We do not contemplate that either the educational or financial administration of the Central College should be vested entirely in His Majesty's Government. Indeed, in the present case there is a special consideration which makes such an arrangement practically impossible. Our scheme, if carried into effect, will entail the hearty union and cooperation of several independent bodies in a common enterprise, and it would be an advantage to be able to accord to each cooperating institution an adequate share in the general control.

These considerations point to the creation of a council representing all the large interests concerned, including, of course, His Majesty's Government, who must always remain by far the chief supporters of the institution. We do not now enter into the details of an arrangement of the constitution of the council, as such details will largely depend on the success of negotiations which must await the decision of His Majesty's Government on the outlines of our proposals as now submitted.

Should the above proposals be accepted, it will follow that the State contribution to the institution will take the form of an annual grant in aid, the governing body retaining the power to carry over any balance remaining unexpended at the end of a year.

V. We feel that we should not be justified in inquiring whether the Board of Education would be willing to give their support to the foregoing scheme, depending as it does on the fulfilment of all or most of the conditions previously mentioned, unless we had taken steps to ascertain what prospect there is of their being fulfilled. We have good reason to believe that private munificence is prepared to provide a capital sum in excess of the minimum which we consider necessary to a successful issue, and that the Commissioners of the 1851 Exhibition are prepared, with their accustomed liberality where the advancement of higher education is concerned, to make available for a scheme, such as we have sketched, the additional site which will be required. We also confidently look for the cooperation of the University of London. Further, although public bodies or local authorities which contribute largely to the funds of the proposed institution may fairly ask for the reservation of some accommodation there for scholarship holders sent to it by themselves, yet it would appear that a considerably increased income would be available for the support of such an institution from the fees of fee-paying students. With this nucleus of additional resources thus provisionally secured, we feel justified in approaching the Board of Education. We accordingly desire to ask whether the Board are in a position to inform us (1) that, if it is found possible to establish a scheme such as we have sketched in outline, they will be willing to allow the Royal College of Science (including the Royal School of Mines) to be brought into it under a common government and administration; and (2) that the existing Government contribution to the support of these institutions will be continued under the new conditions on the scale already made necessary by the provision of the new laboratories of the Royal College of Science.

With such an assurance, and with such new resources as we have mentioned above, we feel that we could approach, with good prospect of success, other bodies whose cooperation we believe to be desirable, if not necessary, for the complete success of our proposals.

In conclusion, we desire to observe that absence of detail where it might have been looked for in certain portions of our proposals is not to be taken as meaning that we have not considered in some detail the ends which we wish to see attained. Our proposals at the present stage indicate only in outline what we have in view: how near an approach can be made to its attainment must depend on the resources which prove to be available, and cannot, therefore, from the nature of the case, be estimated with precision at the present time. Without, however, attempting now to exhaust the subject, we have submitted proposals framed in such a way as to suggest the establishment of an institution which will be pre-eminent in its combination of advanced teaching in certain branches of applied science, with instruction in pure science also developed to a very high standard.

We have the honour to be, My Lord Marquess, Your Lordship's obedient servants, R. B. Haldane, chairman, W. de W. Abney, E. H. Carbutt, W. S. Church, A. H. Leech, Philip Magnus, Walter McDermott, Francis Mowatt, F. G. Ogilvie, Reay, Arthur W. Rücker, Sidney Webb, J. Wernher, W. H. White, J. C. G. Sykes, secretary, F. E. Douglas, assistant secretary.

Letter from the Board of Education to the Secretary of the Departmental Committee on the Royal College of Science, &c.

BOARD OF EDUCATION, WHITEHALL, S.W., *April* 3, 1905.

Sir,

I am directed by the Board of Education to state that careful consideration has been given to the very valuable Preliminary Report of your Committee, dated February 20,

and I am to say that, while the point raised in subsection (2) of paragraph V. on page 5 of that Report cannot yet be definitely decided, the answer to subsection (1) in that paragraph is in the affirmative.

In sending this information, with the consent of His Majesty's Government, I am directed to express the warm appreciation of this Board for the great care with which this difficult subject has been thus far investigated by your Committee, and to say that the necessary discussions with His Majesty's Treasury upon the point involved in subsection (2) of paragraph V. will be completed with the least possible delay and, on a settlement being reached, information will be promptly sent to you as to these financial arrangements.

I have the honour to be, Sir, Your obedient Servant,

ROBERT L. MORANT, *Secretary of the Board of Education.*

Extract from the Speech of the Marquess of Londonderry, President of the Board of Education, at the Annual Dinner of the Institution of Mining and Metallurgy, May 10, 1905.

"I need not say that we have the hearty goodwill of the Treasury in endeavouring to carry out the recommendations of this strong Committee presided over by my friend, and I am able to tell you that, so far as the question of money—and, after all, money is the important question—is concerned, I have good grounds for believing that the Treasury, or rather the Chancellor of the Exchequer, has been very carefully considering the financial aspect of the new condition of things that will be brought about in regard to the Royal College of Science, if the changes I have hinted at actually take effect, and that he will see his way to make a reasonable increase in the sums at present devoted towards the expense of the Royal College of Science, so that the College, in its immensely enhanced possibilities of usefulness, owing to its large new buildings, may bring to the common aid, so to speak, not only its fabric and its excellent equipment, but also a satisfactory annual income, as a substantial contribution to what must be a heavy annual expenditure involved in the great work to be carried through."

NATIONAL LEAGUE FOR PHYSICAL IMPROVEMENT.

A MEETING, over which the Lord Mayor presided, was held at the Mansion House on June 28 for the purpose of establishing an association which for the time is described as a National League for Physical Education and Improvement, but the precise official title of which has not yet been decided. Among those present were the Bishop of Ripon, Sir Lauder and Lady Brunton, the Lord Chief Justice, Sir William Broadbent, Sir James Crichton Browne, Sir Norman and Lady Lockyer, Sir Henry Cunningham, Sir Henry Craik, Sir Benjamin Baker, Prof. Howard Marsh, and Sir Victor Horsley.

The chief objects of the association are to stimulate public interest in the physical condition of the people throughout the kingdom, to establish close association and centralisation of all societies and individuals trying to combat such influences as tend to produce national physical deterioration, to aid existing organisations, and to start organisations for physical health and well-being wherever none exists. As the purposes of the league are closely connected with medicine, it has been thought advisable to have it strongly backed by medical men before other classes of the community are asked to join, because most of them are less able to judge of its merits or demerits than medical men, and will consequently be led to decide their action in regard to it chiefly by the example of the leaders of the medical profession.

The council has published a draft scheme of the proposed association, according to which it would consist of territorial branches working in connection with a central body. It is suggested that each branch should see that instruction is furnished to the people on the laws of health generally, to mothers on the care of their own health and on the nurture and care of children, to girls on the methods of domestic and personal hygiene, and of cooking and housekeeping. Physical exercises and opportunity for open-air games should be obtained for both boys and girls; while the natural desire of young men to become volunteers should be encouraged, and marching drill, shooting practice, and all healthy sports fostered. A plan is outlined also for securing the cooperation of all persons in authority in different centres of population so that each section of the community may receive ultimately physical education of a suitable kind.

The following resolutions were adopted at the meeting:—

(1) That the causes which tend to impair the health of the nation, as disclosed by the report of the departmental committee, ought to be combated by united action. It is, therefore, recommended that all the agencies at present engaged in isolated work for that purpose should have the opportunity of combining, and thus cover the whole country.

(2) That this meeting assembled at the Mansion House, under the presidency of the Lord Mayor of London, therefore heartily approves of the federation designed for this purpose, and of the proposed effort to start organisations in those parts of the country where none exist.

In proposing the first resolution, the Bishop of Ripon said the result of the inter-departmental committee's report had been to point out that there are certain conditions at work which are not creditable to the civilised community. The report states that still-births ought to be registered, and that infantile mortality is very great; and that whereas during the last fifty years an improvement has taken place in the health of the people and in their dwellings, and the average length of life has been increased, it yet remains true that the percentage of infantile mortality has not decreased. The number of deaths in a year per thousand among children was 154 in the decade from 1851 to 1860, and the figure was the same in the decade 1891 to 1900. This shows that the benefits of the improved conditions go to the adult and not to the child. Conditions exist which must be remedied if the health of the population is to be sturdy, robust, and vigorous. The awakened interest in the question is largely due to the agencies which have been toiling to better the conditions and health of the people. If these agencies or societies and individuals have been able to achieve such admirable results by isolated effort, then by federation they could do a great deal more. The federation needs the cooperation of three great classes of public workers—the practical, the scientific, and the Parliamentary. A council would thus be formed of well digested and well considered thought as to the best means of helping forward every agency and initiating every kind of new enterprise which might contribute to the health, well-being, and physical stature, as well as to the moral greatness of the people of this country.

In seconding the resolution the Lord Chief Justice urged that innocent amusement and healthy education be provided throughout the country, through the municipal authorities, for a reasonable proportion of the lads and girls, so that their tastes may have an opportunity of being developed in a wholesome and healthy way.

THE UNIVERSITY COLLEGE OF SOUTH WALES.

THE Prince of Wales, in his capacity of Chancellor of the University of Wales, visited Cardiff on June 28 for the purposes of laying the foundation-stone of the new University College buildings in Cathays Park and of conferring a number of honorary degrees of the University of Wales.

The ceremony of laying the foundation-stone took place in the afternoon in the presence of a large and distinguished assembly. The president of the college, Sir Alfred Thomas, read an address of welcome to the Prince of Wales in which he outlined briefly the events which have led up to the possibility of the provision of buildings worthy of the educational work being accomplished by the University College of South Wales. The address stated that the Government in 1882 invited proposals from public

bodies for the location of the University College of South Wales and Monmouthshire. In their memorial the corporation of Cardiff promised that, in the event of Cardiff being selected, they would make adequate provision for the college.

The address continued:—"How they recognised their obligations is manifest by the noble site upon which we now stand. Your Royal Highness, by your presence here to-day, places the seal of your approval on the manner in which the corporation has redeemed the pledge which I, then as mayor, made in their name. We have had the good fortune to secure the services of an architect whose plans and designs have won the enthusiastic approval of educational experts. By the contributions of the people of South Wales and the splendid munificence of the Worshipful Drapers' Company, we are now in a position to build and maintain the arts, the administrative, and the research departments of the college. Our treasurer, to whom and to whose family we are so deeply indebted, trusts that this ceremony will prove such a stimulus to the patriotism of our people that the work now begun by Your Royal Highness will not cease until the whole scheme is completed."

During the course of his reply, the Prince of Wales remarked:—"As Chancellor of the University of Wales I am delighted to take part in this important ceremony and to lay the foundation-stone of the first block of what is hoped will some day grow into a building beautiful and dignified in design, complete and practical in its equipments. I congratulate you and all here present to-day in the proud fact that it is the liberality of the people of South Wales and Monmouthshire that makes it now possible to carry out a portion of the great scheme for the establishment in Cardiff of buildings worthy of their University College and worthy of the conception of its founders. I further note with great satisfaction that one of the largest of the London city companies has shown a practical sympathy in this great undertaking, and that the library buildings, one of the most important features in any college, will be the gift of the Worshipful Company of Drapers."

After referring to the fact that the site of the new buildings was formerly a monastic centre of learning, renowned at home and abroad, His Royal Highness continued:—"The new teaching and training differs in character from that which in the past rendered her colleges famous, for the Welsh people have determined that their university education shall be compatible with the modern wants of a new world. Its promoters and its authorities have recognised that this university should not exist merely for the purpose of the literary or the academic life, but should place itself in touch with and try to serve every form of intellectual activity, and to-day Cardiff is a constituent of the university, for under the charter the town council appoints two members of the university court, and by a standing ordinance of the town council the mayor is *ex officio* one of the members. So our university is by its constitution interwoven more closely perhaps than any other with the national life of the country; and this is no mere sentiment on the part of the people of Cardiff, for they have not only given this site for the college, but also presented to the university itself another site in this park and 6000*l.* for the erection of its registry."

The University College at Cardiff was founded in 1883 and incorporated in 1884, and is the largest of the three colleges constituting the University of Wales. It began with 150 students. In 1893 the number had increased to 347, and in 1903 to 647. Since its foundation the college has been housed in temporary quarters which used to be the premises of the Cardiff Infirmary. In 1895 the Government promised a grant of 20,000*l.* on condition that an equal amount was raised from private sources, and this was done. Then the Drapers' Company offered 10,000*l.*, which has subsequently been increased to 15,000*l.* The town gave the site, and altogether 132,000*l.* has been contributed. The total cost of the new buildings is estimated at 290,800*l.*, so that about 159,000*l.* is still required.

The conferring of degrees took place later in the day, and among the recipients of honours was Sir John Williams, upon whom the honorary D.Sc. was conferred.

THE LIÉGE MINING AND METALLURGICAL CONGRESS.

At the International Congress of Mining, Metallurgy, Mechanics, and Applied Geology held at Liége on June 25 to July 1, of which a brief report was published in Nature last week, numerous papers of great scientific interest were read.

In the geological section an important paper on the continuation of the Saarbrücken Coal-measures into the territory of Lorraine and of France was submitted by Mr. B. Schulz-Briesen (Düsseldorf). In recent years numerous coal discoveries have been made in the Saarbrücken field by the Prussian Government in an area that had been untouched up to the end of the last century, the beds of quicksand above the coal having proved an obstacle. In French Lorraine coal was discovered last year at a depth of 650 metres. A map accompanying the author's paper indicated the coal-bearing area that has been proved, and showed the vast economic importance of the discovery. The genesis of metalliferous deposits and of eruptive rocks formed the subject of a paper by Mr. Paul F. Chalon (Paris). He summed up the matter in the following rules:—primary metalliferous deposits are not met with in stratified rocks that are not traversed by eruptive or igneous rocks; rocks with a fragmental structure contain more metalliferous deposits than compact rocks; in extended areas traversed by eruptive rocks the deposits are never regularly or irregularly distributed, but are concentrated at one or more centres; metamorphic rocks indicating the vicinity of eruptive rocks are favourable for prospecting, particularly in mountainous districts. The geological structure of the mining district of Iglesias, in Sardinia, was described by Mr. G. Merlo. The district is one of considerable economic importance, there being 117 mines in operation, and the value of the mineral output is more than 21 million francs annually. The principal deposits are veins of galena and blende, and contact deposits of galena and calamine. The Palæozoic beds of the district are, in descending order, as follows:—(1) Monteponi sandstone; (2) Gonnesa schist of Silurian age; (3) Cambrian sandstone; (4) metalliferous limestone; (5) Malacalzetta slates. There are thus three horizons of the Cambrian system. The mineral deposits of the banks of the Meuse and of the east of the province of Liége were described by Mr. G. Lespineux. He showed that these calamine masses, like those of the Moresnet district, are not the results of erosion of mineral veins, but were formed in their present condition. The deposit of cinnabar at Monte Amiatia, in Tuscany, was described by Mr. V. Spirek. The deposits occur exclusively in serpentine, and were divided by the author into four classes.

In the metallurgical section the papers read were mostly of a practical character. Mr. Hadfield gave a summary of his researches on the effect of the temperature of liquid air on the properties of steel. Mr. F. Jottrand described a method of cutting metals by a jet of oxygen. The oxyhydrogen blowpipe is directed against the portion to be cut, and heats it to whiteness. The hydrogen is then turned off, and a rapid current of pure oxygen cuts the metal. In practice two blowpipes are used simultaneously, one for heating and one for cutting. The double blowpipe moves at a velocity of 20 centimetres per minute in cutting a steel plate 15 mm. in thickness. The metal is cut almost as cleanly as with a saw. The width of the slit is not more than 2 mm. for plates 15 mm. thick, and is only 3 mm. for plates 100 mm. thick. In order to cut a plate 15 mm. thick there is required per metre cut 540 litres of hydrogen and 540 litres of oxygen, the operation lasting five minutes. Tubes and curved sections can also be cut. Mr. H. Hennebutte described the use of coal poor in agglutinating materials for the manufacture of coke. Mr. E. Bian gave an account of the methods of cleaning blast-furnace gases. Mr. P. Delville read a paper on the influence of titanium on iron and steel. The manufacture of blast-furnace slag cement was dealt with by Prof. H. Wedding and by Mr. C. de Schwarz. Mr. P. Acker described the new modifications of the open-hearth steel process. Mr. R. M. Daelen discussed the methods of obviating "piping" in steel ingots. Electric steel-making processes were dealt with by Mr. G. Gin and by Mr. R.

Pitaval. Mr. L. Guillet, Carnegie scholar of the Iron and Steel Institute, submitted an elaborate monograph on special steels. Of the nickel steels described, the most remarkable are Guillaume's *invar*, with 36 per cent. of nickel, with an elastic limit of 70 to 75 kg. per square mm., a breaking stress of 45 to 55 kg. per square mm., and an elongation of 35 to 25 per cent.; and *platinite*, with 46 per cent. of nickel, with an elastic limit of 60 to 70, a breaking stress of 30 to 40, and an elongation of 45 to 35 per cent. The latter is used instead of platinum in incandescent lamps. The paper summarises in an admirable manner the existing knowledge of nickel, manganese, chromium, tungsten, molybdenum, vanadium, silicon, and aluminium steels. Other papers read in this section dealt with the application of electricity in rolling mills, by Mr. L. Creplet; the double hardening of large steel forgings, by Mr. A. Pierrard; the metallographical examination of iron and steel, by Mr. H. Le Chatelier; and an apparatus for charging mercury furnaces so as to obviate the liberation of deleterious gases, by Mr. V. Spirek.

In the mining section, papers on shaft sinking were read by Messrs. Bodart, Portier, Tomson and Duvivier, and on winding engines by Mr. Henry. The use of superheated steam was dealt with by Mr. Weiss, and the use of steam accumulators by Messrs. Rateau and Chaleil. Modern pumping engines were described by Mr. Schulte, the De Laval high-lift centrifugal pump by Mr. Sosnowski, and the Sulzer high-lift centrifugal pump by Mr. Ziegler. The water-flush system of packing colliery workings was described by Mr. Jüngst and by Mr. Lafitte. Fire-damp detection was dealt with by Messrs. Chesneau, Watteyne, Stassart, and Daniel. Electric haulage was discussed by Messrs. Lapostolet, Halleux, and Henry; and the driving of the great adit-level from Gardanne to the sea was described by Mr. Domage. Altogether the programme was one of great interest, and the discussions on the papers were well sustained. The president of the congress was Mr. Alfred Habets, and the presidents of the sections were:—for metallurgy, Mr. A. Greiner, member of council of the Iron and Steel Institute; for mining, Mr. E. Harzé; for mechanics, Mr. Hubert; and for geology, Mr. Max Lohest. Among the honorary presidents of the sections who presided in turn were:—for metallurgy, Mr. R. A. Hadfield, president, and Mr. H. Bauerman, honorary member of the Iron and Steel Institute; and for mining, Mr. H. C. Peake, chairman of the Institution of Mining Engineers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Prof. G. H. Darwin for the degree of D.Sc. *honoris causa* at the Encænia on June 28:—

Salutamus Georgium Howard Darwin, magni patris magnum filium, non solum inter astronomos insignissimum, sed, ut decebat tali patre ortum, quasi clavis repertorem qua altissima naturæ arcana reseraret. Ille quidem, Carolum dico, de vita animantium doctor insignissimus, ostenderat quo modo sensim immutata figura simplicioribus et rudioribus perfectiora animalia succederent: hic noster docuit quo modo ipsa mundi compages lentas mutationes subiret. Duces quidem in hac re secutus est Newtonum, Laplacium, Kelvinum, sed suis viribus fretus est magis. Quid enim? Omnia quæ de reciproco maris motu litteris tradita sunt ipse denuo pertractavit, siderum cælo decurrentium meatus summa diligentia et scientia amplissima investigavit: idem tenuissimo quoque et subtilissimo mathematicæ genere instructus, ingenio audaci et vegeto pollens, luculentissime ostendit quo momine et nutu variæ maris agitationes tam multiplices gignantur: quod cum faceret id assecutus est ut terræ, lunæ, solis, planetarum primordia et vices satis clare adumbraret. In hoc viro agnoscimus hominem, dictu mirum, mundorum nascentium annales conscribentem.

CAMBRIDGE.—The Raymond Horton-Smith prize for 1905 has been awarded to Dr. W. L. H. Duckworth, of Jesus College, for a thesis for the degree of M.D. entitled "On the Nature of Certain Anomalous Cases of Cerebral Development."

SUBJECT to the Enfield Council agreeing to contribute one-third of the total cost of the buildings and necessary alterations, it has been decided by the Middlesex County Council to acquire the Ediswan Institute, Ponders End, the object being to convert it into a technical institute for the eastern portion of Enfield, that suitable technical instruction may be given to those engaged in the Small Arms Factory, Enfield Lock, the works of the Edison and Swan Co., &c.

A NEW movement for the encouragement of tropical research has been inaugurated in connection with the University of Liverpool. The school of research, of which Lord Mountmorres is to be the first director, will seek in every way to inquire into the natural resources of the tropical possessions of the Empire. Sir Alfred Jones, of the Elder-Dempster line of steamers, has promised to contribute 1000*l.* a year for four years towards the expenses of the movement.

ACCORDING to *Science*, the following appointments have recently been made in America:—Dr. A. W. Harris, president of North-western University; Dr. C. H. Smyth, professor of geology at Princeton University; Dr. N. Senn, professor of surgery, and Dr. F. Billings, professor of medicine, at the University of Chicago; Dr. H. K. Wolfe, professor of philosophy and education at the University of Montana; Mr. I. E. Wallin, professor of natural history in Upsala College, New Orange, N.J.

THE department of general pathology and bacteriology of King's College, London, announces a course in clinical and practical bacteriology suited to the requirements of medical practitioners and senior students. The course, which will begin on July 26 and end on August 5, will consist of lectures, demonstrations, and practical work. In connection with the same department there will be from July 27 to August 4 a vacation course in clinical pathology consisting of demonstrations and practical work. Further particulars may be obtained from Prof. Hewlett or the secretary of the college.

DURING the coming session courses of general and experimental psychology will be held at King's College, London. During the first and second terms Prof. Caldecott will deliver a series of lectures on general psychology. Prof. W. D. Halliburton, F.R.S., will lecture during the first term on the general structure and histology of the nervous system and of the organs of sense. During the second and third terms lectures on experimental psychology, accompanied by demonstrations and laboratory work, will be given by Dr. C. S. Myers in the new psychological laboratory. A departmental library has been opened at the college containing the principal English and foreign books and journals devoted to psychology.

THE Department of Agriculture and Technical Instruction for Ireland has issued its regulations and syllabuses to guide the teaching of science in Irish day secondary schools for the session 1905–6. The complete conditions regarding regulations for grants, qualifications of teachers, syllabuses of subjects, and a list of official forms are now issued in a single volume. The regulations are materially the same as those which were in force during last session. Some few syllabuses have been modified in the light of the experience gained in the last two years. It is announced that the summer courses for teachers will be continued as heretofore, but it is hoped they will, after 1908, develop into "post-graduate courses on special subjects for those already qualified."

THE British University Students' Congress met on June 28 at University College. All the universities of the United Kingdom were represented except Oxford and Cambridge, these having no organisation which can send delegates to represent their undergraduates generally. The report of the subcommittee appointed last year to consider the question of residential halls at home and abroad was presented. Fourteen British universities and colleges,

eleven American universities, and four Australian universities have been communicated with. It was resolved to elect a committee to formulate recommendations as to what should be done to help to develop the residential system. It was decided also to extend the scope of the constitution of the congress so as to include delegates from the universities of Ireland as well as of England and Wales, and to invite universities of Scotland also to send representatives annually.

It is announced that Mr. J. D. Rockefeller has given 2,000,000*l.* to the General Educational Board, a body incorporated by a recent Act of Congress for the purpose of promoting education in the United States, and the income is to be used for the extension of higher education in the United States. Mr. Rockefeller has also presented 200,000*l.* to Yale University. It is stated the gift to the Educational Board is to be held in perpetuity, and the income, after payment of administrative expenses, is to be used for the benefit of such institutions as the Board may select for periods, in amounts, for purposes, or on conditions to be determined by the Board, which may also employ the income in such other ways as it may deem best adapted to promote a comprehensive system of education in the United States. The income is to be used without distinction of locality, and its use is to be confined to higher education. It is designed especially for colleges as distinguished from the great universities, although there is no prohibition of grants to universities. The benefits of the donation are to be open to all, although the fund cannot be employed for giving specifically theological instruction. The fund may be used for endowment, for building, for paying off debts, or meeting current expenses.

The report for the year 1904 of the council to the members of the City and Guilds of London Institute has been received. We notice that the number of university students attending the Central Technical College continues to increase, and that more than 110 such students are in attendance during the current session. At the last degree examination in engineering for internal students of the university, open to all engineering schools in London, eleven degrees in all were conferred, and of these eight were obtained by this college. The total number of students in the college during 1904 was 409, as compared with 304 in the preceding year. This increase in number of the students has made it necessary to provide an increase in the teaching staff, and the appointment of five new assistants has been sanctioned at a cost in salaries of 800*l.* a year. The council, in their last report, announced the steps which had been taken towards the extension of the building of the Technical College at Finsbury. Since then the plans of the new building have been approved, a tender accepted, the foundations excavated, and the building begun. In settling the details of the plans and on the question of the equipment of the new building, the committee had the benefit of the advice of Sir William White, K.C.B., F.R.S. The work of the department of technology of the institute continues to increase with the growing demand for instruction in the application of science and art to specific industries and trades. There are two directions in which, in the opinion of the council, improvements might be effected in the technical education of artisans. First, in the preparation of students before entering upon their courses of evening technical instruction, and secondly, in the standard of qualifications of the teachers nominated by local authorities to give such instruction. It is satisfactory to find that in the different branches of technology the number of students registered as attending classes in the United Kingdom was 41,089, as compared with 38,638 in the previous year. The report as a whole is an excellent record of a substantial year's work.

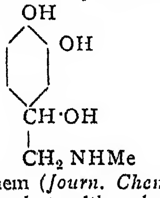
SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, June 7.—Mr. F. Merrifield, president, in the chair.—An earwig, *Apterygida arachidis*, Yers., found by Mr. Annandale, of Calcutta, in a box of specimens received from the Andaman Islands: M. **Burr.** When placed in a small box the earwig was alone, but next morning there were five larvæ present; two disappeared, apparently being consumed by the parent, and the remaining three were those exhibited. Mr. Burr also showed a locustid of the family Pseudophyllidæ, taken in Queensland by Mr. H. W. Simmonds among twigs and plants which it greatly resembled, together with a photograph of the insect in its natural position.—(1) Three examples of *Gnorimus nobilis*, L., taken at Woolwich on May 20 last under the bark of an old dead cherry tree, a beetle supposed to be becoming extinct in Britain; (2) a malformed specimen of *Lochmaea suturalis* which had the left posterior tibia bifid for about one-third of its length, and two tarsi, one of which had the joints considerably enlarged: E. C. **Bedwell.**—A living specimen of *Omophlus betulae*, Herbst, a beetle not known to occur in Britain, found near Covent Garden, and probably imported: O. E. **Janson.**—One ♂ and three ♀♀ of *Agrion armatum* taken this year by Mr. F. Balfour Browne, and sent to the exhibitor alive: W. J. **Lucas.**—Four specimens of the rare *Acrognathus mandibularis*, Gyll, captured on the wing towards sunset near Woking at the end of May: G. C. **Champion.**—Two aberrations of *Biston hirtaria*, Cl., both females, taken at rest on tree-trunks at Mortehoe, North Devon, April 23: Selwyn **Image.** The first aberration was tolerably normal in general coloration, but the anterior half of the fore-wings was much suffused with fuscous, and at the costa was broadly emphasised with rich black. The second aberration was semi-transparent black all over both fore- and hind-wings, the veins strongly delineated with black, powdered with ochreous.—Empty pupa-cases of *Zonosoma pendularia* demonstrating the wide variation of methods in the placing of the silken girth round the pupa: W. J. **Kaye.**—Leaves of strawberry, *Berberis japonica*, and cherry-laurel which had been attacked by a minute fungus—in the case of the Berberis identified by Prof. S. H. Vines as *Phyllosticta japonica*, Thnem.: Prof. E. B. **Poulton.** The attack was local, leaving a roundish or oval window outlined with brown, sometimes in the form of a narrow line, sometimes spreading peripherally into the leaf for a greater or less distance. In the strawberry leaves the edges of the windows were somewhat ragged, but those of the other two leaves had smooth contours, and resembled strikingly the oval transparent areas upon the fore-wings of *Kallima inachis*, *K. paralekta*, &c. Prof. Poulton had believed that these "windows" of Kallima represented holes gnawed by larvæ, and that the altered marginal zone reproduced the effect of the attacks of fungi entering along the freshly exposed tissues of the edge. But he now desired to withdraw his earlier hypothesis in favour of the more probable and convincing suggestion made by Mr. Grove.—Photograph of the fungus-like marks on the wings of the Oriental Kallimas: Prof. **Poulton.**—The variability of the genitalia in Lepidoptera: Dr. Karl **Jordan.**—Scents in the male of Gonepteryx: Dr. G. B. **Longstaff.** It was mentioned that whereas in *G. cleopatra* ♂ the odour was strong, the author had been unable to detect any appreciable fragrance in *G. rhamni* ♂. Such a difference, he said, seemed to imply a physiological difference of the two forms pointing to specific distinction. Dr. F. A. Dixey, in connection with Dr. Longstaff's observations, exhibited and explained the several forms of Gonepteryx occurring in the Palæarctic region.—The geographical affinities of Japanese butterflies: H. J. **Elwes.** Summing up his remarks, the author said that during the winter and spring months the plants and insects of Japan were, like the climate, Palæarctic in character, yet during the summer and autumn they were tropical.—New African Lasiocampidæ in the British Museum: Prof. C. **Aurivillius.**—Memoir on the Rhynchota taken by Dr. Wyllie chiefly in Beira and Lifû: G. W. **Kirkaldy.**

Chemical Society, June 14.—Prof. R. Meldola, F.R.S. president, in the chair.—Influence of various sodium salts on the solubility of sparingly soluble acids: J. C. **Philip.**—The dielectric constants of phenols and their ethers dissolved in benzene and *m*-xylene: J. C. **Philip** and Miss D. **Haynes.**—Synthesis by means of the silent electric discharge: J. N. **Collie.** The facts of special interest are that ethylene under the influence of the silent electric discharge at the ordinary temperature will unite with carbon

monoxide, and will also polymerise, yielding a series of complicated hydrocarbons; the chief substances formed boil at about 150°–160°, and apparently approximate in composition to $C_{10}H_{20}$.—The ultra-violet absorption spectra of aromatic compounds, part i., benzene and certain mono-substituted derivatives: E. C. C. **Baly** and J. N. **Collie.** The ultra-violet absorption spectra of benzene and of some of its mono-substituted derivatives were described. It has been found that benzene presents seven separate absorption bands, and it was shown how the formation of these may be accounted for by attributing each one to a separate and distinct process of dynamic isomerism connected with the linkage changes within the benzene molecule. A similar explanation of the absorption spectra of benzene mono-substituted derivatives was given.—The ultra-violet absorption spectra of aromatic compounds, part ii., the phenols: E. C. C. **Baly** and E. K. **Ewbank.** The absorption band produced by the dynamic isomerism existing in solutions of acetylacetone and similar tautomeric substances of the aliphatic series occupies very nearly the same position as the band given by phenol. The existence of a similar type of dynamic isomerism in the case of phenol is suggested as explaining the difference between the spectra of phenol and its ethers.—Association in mixed solvents: G. **Barger.**—Synthesis of substances allied to epinephrine: G. **Barger** and H. A. D. **Jowett.** The authors have attempted to synthesise a compound having the formula



proposed by one of them (*Journ. Chem. Soc.*, 1904, lxxxv., 192) for epinephrine, but although the methylene and dimethyl ethers were prepared, the base itself could not be isolated.—The determination of melting points at low temperatures: L. F. **Guttmann.** A method has been worked out for readily determining melting points at low temperatures (−142° to −55° is the range so far used) by means of a constantan-copper couple connected to a delicate galvanometer.—The action of water on diazo-salts, a preliminary note: J. C. **Cain** and G. M. **Norman.** One of the authors has shown that little or no hydroxy-compound is obtained by boiling certain ortho-substituted diazo-salts of the diphenyl series with dilute acids. A number of similarly substituted compounds which are said not to yield phenols on boiling with water or acids have now been examined.—A precise method of estimating the organic nitrogen in potable waters: J. C. **Brown.** The process consists in distillation to dryness of a mixture of a portion, without previous evaporation, with potassium hydroxide and potassium permanganate. The ammonia evolved is estimated by Nessler's solution.—Synthesis of 1 : 1-dimethyl-Δ^3-tetrahydrobenzene: A. W. **Crossley** and Miss N. **Renouf.**—Bromine in solutions of potassium bromide: F. P. **Worley.**—The solubility of bromine in aqueous solutions of potassium bromide has been determined over a wide range of concentrations at 18°·5 and 26°·5. There are indications that with the higher concentration of bromine, compounds more highly brominated than KBr_3 are produced.—Tetramethylammonium hydroxide: J. **Walker** and J. **Johnston.** A solution of tetramethylammonium hydroxide is readily prepared by mixing alcoholic solutions of tetramethylammonium chloride and potassium hydroxide.—Tetrethylsuccinic acid: J. **Walker** and Mrs. A. P. **Walker.**—The ultra-violet absorption spectra of aromatic compounds, part iii., disubstituted derivatives of benzene: E. C. C. **Baly** and E. K. **Ewbank.**—Studies in chlorination, ii., the action of chlorine on boiling toluene, preliminary notice: J. B. **Cohen,** H. M. **Dawson,** and P. F. **Crosland.** The results show that, under the conditions of the experiments, electrolytic chlorine enters the nucleus only, and also that the rate of chlorination appears to be more rapid than with ordinary chlorine evolved from pyrolusite and hydrochloric acid.—Purpurogallin: A. G. **Perkin.** A description of various derivatives is given.—The electrolytic oxidation of hydroxybenzoic acids: A. G. **Perkin** and F. M. **Perkin.**

PARIS.

Academy of Sciences, June 26.—M. Troost in the chair.—On a determination of the constant of aberration by means of observations of three stars very close to the pole: H. **Renan** and W. **Ebert.** Arising from researches on the determination of latitude and of the absolute coordinates of the circumpolar stars, a long series of accurate observations has become available for the calculation of the constant of aberration. An advantage of this method is that no correction is necessary for the variation of latitude. The final value obtained is 20″·434, with a probable error of 0·030s.—On isothermal surfaces: L. **Raffy.**—The motion of the earth and the velocity of light: M. **Brillouin.** An analysis of the method proposed by M. Wien and M. Schweitzer for solving the problem as to whether the ether is carried on by the earth, in which the author shows that the desired result will not be attained.—An apparatus for controlling actions produced at a distance by means of electric waves: Édouard **Branly.** An account of alterations in an apparatus already described, the chief improvement being the substitution of an electric motor for the clockwork movement.—On the specific inductive power of metals: André **Broca.** In a preceding note the author, with M. Turchini, has shown that the experimental results are not in accord with the theory for the resistance of fine metallic wires for continuous currents and alternating high frequency currents, the calculations being carried out according to Lord Kelvin's hypothesis. In the present note it is shown that the introduction of the specific inductive power, neglected in the first calculations, will account for the observed differences.—On the phenomena of the singing arc: A. **Blondel.**—An apparatus and method for measuring coefficients of magnetisation: Georges **Meslin.** A modification of the arrangement proposed by MM. Curie and Chenéveau.—The hydrolysis of very concentrated solutions of ferric sulphate: A. **Recoura.** A concentrated solution of ferric sulphate in a well closed vessel becomes slowly converted into a solid basic sulphate and a soluble acid sulphate. From the time required for this change the author regards this action as not due to a simple hydrolysis, but as due to a molecular transformation.—Combinations of aluminium chloride with carbonyl chloride: E. **Baud.** Three compounds of these substances are shown to exist, containing aluminium chloride and carbonyl chloride in the following molecular ratios, 1 : 5, 1 : 3, and 2 : 1. The last is found in commercial aluminium chloride.—The constitution and properties of steels containing tin, titanium, and cobalt: Léon **Guillet.** These metals enter into solution in the iron, the carbon being in the form of carbide. The mechanical properties of these steels are such as to prevent their commercial application.—On the reduction of aldoximes: A. **Mailhe.** Aldoximes can be readily reduced to amines by the Sabatier and Senderens reaction, but the primary amine is not the only product. Acetaldoxime gave a mixture of the primary, secondary, and tertiary amines, and œnanthaldoxime behaved similarly; owing to the decomposing action of the reduced nickel on benzaldoxime the reduction of this compound was irregular.—On the bromination of paraldehyde: P. **Freundler.** At a low temperature bromoacetaldehyde can be obtained; under different conditions tetrabromobutyric aldehyde is produced.—On some new β-keto-aldehydes: F. **Couturier** and G. **Vignon.**—The iodomercurates and chloroiodomercurate of monomethylamine: Maurice **François.**—On some derivatives of butyroine and capronoine: L. **Bouveault** and René **Locquin.**—On a bivalent phytosterine alcohol: T. **Klobb.** This alcohol, described in a previous paper under the name of arnisterine, a neutral crystalline principle extracted from *Arnica montana,* has now been shown by its reactions with acetic anhydride, benzoyl chloride, and phenyl isocyanate to be an alcohol containing two hydroxyl groups, and it is proposed to revise the name to arnidiol.—A method for determining the purity of cocoa butter: E. **Milliau.**—The toxicology of mercury-phenyl: E. **Louise** and F. **Moutier.** This substance proves to be only very slightly toxic in comparison with the corresponding compounds of the fatty series.—On the combustion of sulphur in the calorimetric bomb: H. **Giran.** In a preceding paper the author has attributed the variation of the heat

of combustion of sulphur with pressure to the formation of persulphuric acid, but calorimetric determinations carried out with this substance show that this view is incorrect. The effects observed are due to the presence of traces of hydrogen and nitrogen in the compressed oxygen employed.—Oxyhæmoglobin from the guinea-pig, and its reaction with fluorides: M. **Piettre** and A. **Vila**.—On the simultaneous variations of the organic acids in some plants G. **André**.—On the production of a soft cider: G. **Warcollier**. The must prepared for fermentation is freed as far as possible from oxygen, and the fermenting liquid is protected from the air during the process.—The genus Alabes of Cuvier: Léon **Vaillant**.—The physiological signification of the urate cells in solitary honey-bearing insects: L. **Semichon**.—The hæmolytic action and general toxicity of eel serum for the marmot: L. **Camus** and E. **Gley**.—On the presence of poison in the eggs of the viper: C. **Phisalix**. At the moment of ovogenesis in the viper the active principles of the venom accumulate in the ovules, and probably play a part in the development.—On the problem of statical work: Ernest **Solvay**.—The treatment of cutaneous cancer by radium: Jules **Rehns** and Paul **Salmon**. A description of two cases in which radium was used with successful results.—On the existence of a remarkable Pliocene layer at Tetouan, Morocco: Louis Gentil and A. **Boistel**.—On the origin of eoliths: Marcellin **Boule**.—The drawings of the lion and cave bear and of the *Rhinoceros tichorhinus* on the walls of caves by man in the reindeer epoch: MM. **Capitan**, **Breuil**, and **Peyrony**.

GÖTTINGEN

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), parts i. and ii. for 1905, contains the following memoirs communicated to the society:—

February 11.—O. **Wallach**: Researches from the university chemical laboratory, xiv.:—(1) on the constituents of the sage-oils; (2) on the proportion of phellandrene in the ethereal oil of *Schinus molle*, L.; (3) on the occurrence of an alcohol with the properties of pinocarveol in the ethereal oil of *Eucalyptus globulus*; (4) on the semi-carbazone of *d*- and *l*-fenchone, and the occurrence of *l*-borneol ester in Thuja-oil; (5) on the preparation and behaviour of methyl(1)-phenyl(2)-hexene; (6) on the bromine-substitution-products of cyclohexanone and cyclopentanone.

January 28.—A. **von Koenen**: On the underground effects of earth-pressure in salt-mines.

February 2.—Dr. H. **Schering**: Seismic records at Göttingen in the year 1904.

February 11.—W. **Biltz**: Further contributions to the theory of tinctorial processes. (1) Measurements relating to the formation of inorganic analogues of substantive dyes; (2) on the "affinity of condition" of certain sulphuretted dye-stuffs.

February 25.—W. **Nernst** and H. **von Wartenberg**: On the dissociation of water-vapour. W. **Nernst** and H. **von Wartenberg**: On the dissociation of carbonic anhydride. E. **Wiechert**: Remarks on the motion of electrons with velocities exceeding that of light. C. **Carathéodory**: On the general problem of the calculus of variations. L. **Maurer**: On the differential equations of mechanics. M. **Laue**: On the propagation of radiation in dispersive and absorptive media. T. **Tamaru**: Determination of the piezoelectric constants of crystallised tartaric acid. (1) General sketch of theory and method of observation; (2) pressure arrangements and the piezoelectric excitation; (3) electrometric methods; (4) results. D. **Hilbert**: Contributions to the calculus of variations.

NEW SOUTH WALES.

Royal Society, May 3.—Prof. Liversidge, F.R.S., vice-president, in the chair.—On the occurrence of calcium oxalate in the barks of the Eucalypts: Henry G. **Smith**. The author announces the presence, in large quantities, of calcium oxalate in the barks of several species of Eucalyptus. It is similar in form and appearance in all species, being well defined monoclinic crystals in stout microscopic prisms, averaging 0·0174 mm. in length and 0·0077 mm. in breadth, and containing one molecule of water. A peculiarity of these is the tendency to form twins geniculate in appearance, twinned forms being pronounced in some species. From botanical and chemical evidence it is assumed that *Eucalyptus salmonophloia* of West Australia and *E. oleosa* of New South Wales belong to the same species, and that the latter tree, which most often occurs as a "mallee," is only the degenerate stage of the former. The theory is advanced that some of the "mallees," or shrubby Eucalypts, have been formed through the poisoning effect of the excess of oxalic acid acting for a long time upon species which originally grew as large trees. The tannins in those Eucalyptus barks containing a large amount of calcium oxalate are of very good quality, light in colour, astringent, easily soluble, and should make leather of good quality. On evaporating the extract to dryness on the water bath but little darkening takes place, and the product is still readily soluble. This class of Eucalyptus barks should, therefore, make excellent tanning extracts. From the bark residue the calcium oxalate should be profitably extracted, and the oxalic acid obtained cheaply from this, practically as a by-product. The air-dried bark of *Eucalyptus salubris*, the "gimlet" of West Australia, gives 30·5 per cent. of total extract and 18·6 per cent. of tannin absorbed by hide powder, and contains 16 per cent. of calcium oxalate. The bark of *Eucalyptus gracilis* contains 16·66 per cent. of calcium oxalate, that of *E. Behriana* 16·5 per cent., of *E. oleosa* 10·64 per cent., of *E. dumosa* 9·8 per cent., and of *E. salmonophloia* 8·34 per cent. The barks of all the Eucalypts tested contain calcium oxalate, although in some species in very small amount.—Notes of astronomical interest, dealing with the past eighteen months, showing the progress and deductions made during that period: H. A. **Lenehan**.

DUBLIN.

Royal Irish Academy, May 22.—Prof. R. Atkinson, president, in the chair.—On the vegetation of the southern part of county Dublin: G. H. **Pethybridge** and R. Lloyd **Praeger**. The paper dealt with the plant associations of this area, which extends from sea-level to nearly 2500 feet, and embraces more than 200 square miles. A coloured vegetation map and photographs were shown in illustration of the subject.

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THURSDAY, JULY 13, 1905.

THE POPULARISATION OF SCIENCE.

The New Knowledge. By Robert Kennedy Duncan, Professor of Chemistry in Washington and Jefferson College. Pp. xviii+263. (London: Hodder and Stoughton, 1905.)

THE author of this attempt to make the progress of recent discovery in chemistry and physics understanded of the people remarks in his preface:—

"The great expositors are dead, Huxley and Tyndall and all the others; and the great expositor of the future, the interpreter of knowledge to the people, has yet to be born."

And (but it must be added quite modestly) he attempts to wear the cloak of the prophet. He is right, on the whole, when he says that "the progressive teacher, particularly in the high school or smaller college, finds it often exceedingly difficult to gain access to the original sources of knowledge," and, it may also be remarked, to understand them when he does. Hence any serious attempt made by one sufficiently versed in science to avoid error, and with sufficient appreciation of the difficulties of one who has not made science his speciality to know how to present facts and their interpretation, is deserving of a cordial welcome. Indeed, most scientific men are in the position of outsiders towards sciences not their own; and an allusion to the recent effort made by the Chemical Society to present the year's progress to their Fellows is here not inappropriate, for to such an extent is specialisation now carried that it is practically impossible for the physical chemist to follow the researches of the organic chemist, and *vice versâ*. Their "Annual Reports on the Progress of Chemistry for 1904" will be much appreciated by all chemists. It is true that the organic chemist, for example, may consider the amount of space devoted to his branch insufficient, and the treatment of the subject-matter somewhat scrappy; yet to one who has no time to follow in detail the work of the specialists published in numerous journals during the year, a summary like this is of the greatest value. It is very desirable, in subdivisions of a science, as well as in separate sciences, that the bearing of one branch of knowledge on another should be realised, and so far understood; and the Chemical Society is to be congratulated on its new effort. It is to be hoped that a similar plan will be adopted by physiologists, geologists, and, indeed, by all those who labour for the "promotion of natural knowledge."

But to return to Prof. Duncan's book. Beginning with the "three entities," matter, ether, and energy, an attempt is made in seven pages to give the reader some idea that these are the conceptions in terms of which the modern man of science interprets nature. The doctrines of the conservation of mass and of energy, and the necessity for the assumption of the existence of ether are indicated. I doubt whether an entire outsider would gain much by reading this chapter; still, if it stimulates him to think, and to try to acquire clearer ideas on the subject, much will have been accomplished. We have then certain elementary conceptions of chemistry expounded, molecules, atoms, compounds, and elements, and so closes part i., which consists of eleven pages.

To give the reader an idea of the author's style, a quotation from the first paragraphs of part ii. may be made.

"We believe—we must believe, in this day—that everything in God's universe of worlds and stars is made of atoms, in quantities x, y or z respectively. Men and women, mice and elephants, the red belts of Jupiter and the rings of Saturn are one and all but ever shifting, ever varying, swarms of atoms. Every mechanical work of air, earth, fire and water, every criminal act, every human deed of love or valor: what is it all, pray, but the relation of one swarm of atoms to another?

"Here, for example, is a swarm of atoms, vibrating, scintillant, martial,—they call it a soldier,—and, anon, some thousands of miles away upon the South African veldt, that swarm dissolves,—dissolves, forsooth, because of another little swarm,—they call it lead.

"What a phantasmagoric dance it is, this dance of atoms! And what a task for the Master of the Ceremonies. For mark you the mutabilities of things. These same atoms, maybe, or others like them, come together again, vibrating, clustering, interlocking, combining, and there results a woman, a flower, a blackbird or a locust, as the case may be. But to-morrow again the dance is ended and the atoms are far away; some of them are in the fever germs that broke up the dance, others are 'the green hair of the grave,' and others are blown about the antipodes on the winds of ocean. The mutabilities of things, and likewise the tears of things: for one thing after another,

'Like snow upon the Desert's dusty Face
Lighting a little hour or two—is gone,'

and the eternal, ever-changing dance goes on."

Now this purports to be very fine writing, but does it gild the pill of science? I am inclined to think not. Still, tastes may differ.

It would be unfair to judge of the book, however, by this quotation. The subsequent sections deal with the periodic classification, gaseous ions, corpuscles, and here a very lucid account is given of the method of estimating the velocity of a corpuscle, and of the relation of the charge to the mass; really in these sections the author has established his character as a clear expositor. Positive ions are then considered, and then natural radio-activity, in which there is a capital sketch of the discovery of radium and of its properties. A subsequent chapter treats of thorium, uranium, radium, and actinium, with the reproduction of Prof. Rutherford's latest results, and the section concludes with the radio-activity of substances in general. The next "part" deals with the resolution of the atom and with atomic disintegration, and an intelligible account is given of Prof. J. J. Thomson's most recent work. The heat-emitting property of radium is next dealt with, and then there is a summary of the "electrical nature of matter." The book concludes with part v., entitled "Inorganic Evolution and Inorganic Devolution," discussing intelligently and intelligibly Sir Norman Lockyer's theories

relating to stellar temperatures and stellar change, and the problems of the sun's heat, the mechanical pressure of light, and the re-construction of a universe are the concluding chapters. The last chapter of all, the validity of the new knowledge, deals with the question, Is all this true? And here there is a touch of philosophy. For "A system is 'true' if it is entirely consistent and coherent, if it is completely self-explanatory."

"There is no criterion of absolute truth, there is no way of attaining to absolute truth, and we may as well acknowledge it. Should we therefore abandon the world-riddle? Assuredly not. If we may never *know* a system to be true, we may *believe* it to be true. We may not have a knowledge of truth, but we may have a recognition of it." "Meanwhile this system of the new knowledge . . . is simply the outermost circle covering the greatest area of knowledge, and while its diameter is by no means infinite, it is the truest expression of the truth attainable at this time, and as such is vastly useful. Its utility in the evolution of knowledge is its sole apology for existence."

This work is the first attempt which I have seen to bring into suitable compass, in an intelligible manner, the various problems which are occupying the attention of many physicists and chemists. There are few errors, and these are unimportant. Whether the author might not have omitted much fine writing is a question of taste. But even if it be regarded as ill-placed, it does not destroy the intrinsic value of his work. W. R.

THEORETICAL GEODESY.

Trattato di Geodesia Teoretica. By Paolo Pizzetti. Pp. ix+467. (Bologna: Zanichelli, 1905.)

SIGNOR PIZZETTI has treated the subject of geodesy in a thoroughly exhaustive manner. The theoretical portion of the book, dealing with the formulæ used in geodesy, is very ably demonstrated, and the mathematical proofs of the various problems are sufficiently clear to be easily followed by those practically uninitiated in the subject. The same, however, cannot be said of the descriptive narrative of geodetical operations in general. The book, in fact, impresses one far more from the theoretical than from the practical point of view. The absence of practical demonstrations of the use of the various formulæ must be a great loss in a work of this nature, and for this reason it compares unfavourably with such standard treatises as Puissant's "Traité de Géodesie" and Clarke's "Geodesy," where ample practical illustrations of the application of geodetical formulæ are given to help the student in this complicated subject. Even a few examples taken from any modern geodetic triangulation would have been of the greatest assistance. Theory alone is almost bound to have a deterrent effect.

The book contains a short and concise history of the several hypotheses as to the form and constitution of the earth prior to any actual geodetical operations, but the account of the several measurements of "arcs of meridian" is very meagre, and confines itself practically to mentioning those measured in Peru and Lapland in the eighteenth century.

Doubtless these "arcs" played a most important part in geodesy, but subsequent measurements have been of equal importance, and have been carried out with the advantage of superior knowledge and more perfect instruments.

Like most Continental geodesists, the author adheres to the data for the figure of the earth deduced by Bessel in 1840, and it is only in an appendix that any reference is made to Clarke's determination. This, I think, is scarcely fair to English geodesy, considering that Clarke had the advantage of a far larger number of arcs whence to deduce his values, as given in his excellent treatise in 1880. A reference to these values should find a place in every standard work on geodesy, and it is noteworthy that the American Geodetic Survey, which previously employed Bessel's values, has, within recent years, discarded them in favour of Clarke. This was in great part due to the close agreement between Clarke's values and those deduced by the Americans themselves in their various arc measurements.

Several chapters are devoted to the mathematical proof of the various functions of a spheroid of revolution. On the whole, they are easily followed, and differ but slightly from those used by Puissant in his great work. The formulæ in chapter iv. for the determination of the geographical coordinates are similar to those used in the Indian auxiliary tables. Here, particularly, the want of definite examples is greatly felt, and I cannot but think that Signor Pizzetti would greatly enhance the value of his work by adding a few taken at hazard from any survey. The actual illustration given in this chapter is one but rarely used in geodesy.

Three chapters are given up to the description of base measurements and the practical observation of geodetic angles. It may at once be said that the account is far from thorough, and the practical student desirous of studying the methods to be employed in the field would glean but a scanty knowledge. Mention is made of some of the more important instruments used in base measurement, such as Borda's rods, Ibenaz's apparatus, and the American contact duplex bars, but no word is given of Colby's compensation bars, and only the slightest reference is made to measurements by means of steel or invar tapes or wires. There is little doubt that in future all geodetic bases will be measured by the latter means. Only quite recently in South Africa bases have been measured with an extraordinary degree of precision with invar wires.

As regards the measurements of the angles, there is but little information as to the practical work to be done, but a very exhaustive treatise is given of the causes of the various instrumental errors. It is mainly in agreement with those chapters in Chauvenet's "Astronomy" dealing with this subject.

Reference is made to the various instruments used for astronomical work, such as transit—altazimuth—and zenith telescopes. The various errors to which such instruments are liable is very carefully gone into.

A short history is given in chapter viii. of the general development of triangulation from the time of Snellins to the present day, but it consists mainly in mentioning some of the more striking incidents connected with the subject, such, for instance, as the use of electric light in the work connecting Spain and Algiers.

The question of lateral refraction is gone very fully into, and a table is given showing the mean triangular errors proportional to triangles of different sizes. The deduction is then made that the effect of lateral refraction increases with the mean length of a side of a triangle up to about 90 kilometres, after which it begins to decrease again. This is a particularly interesting problem, and the table, which is taken from a recent triangulation in Germany, certainly confirms the deduction. It is of course assumed that the closing errors of triangles are due in most part to lateral refraction. The usual methods of calculating and computing triangulation are very thoroughly dealt with.

Precise levelling forms the greater part of chapter ix., but an exceedingly full and clear demonstration is given at the beginning of the various formulæ relative to atmospheric refraction and to trigonometrical differences in heights of stations. This is treated in a really very clear manner.

Three chapters are devoted to the theory of probability and its application to geodesy. The theoretical portion has been well demonstrated, and differs but little from the numerous text-books on this subject; but where the attempt is made to apply the method of least squares to a network of triangulation, the want of taking a practical example is at once felt. Clarke, in his "Geodesy," gives numerous examples of how to apply theory to practice, but Signor Pizzetti leaves the student utterly in the dark on this important point.

Perhaps the two most interesting chapters are left to the end. They deal with the subject of projections, which is gone into with every care. There is scarcely any well known projection which is not very fully explained.

Altogether this book is a distinct addition to any geodetic library. W. J. JOHNSTON.

OUR BOOK SHELF.

The Food Inspector's Handbook. By Francis Vacher. Fourth edition. Pp. xvi+231; illustrated. (London: The Sanitary Publishing Co., 1905.) Price 3*s*. 6*d*. net.

THIS is a pocket volume intended for the use of sanitary and other officers concerned in the inspection of food. It describes, in simple, untechnical language, the naked-eye characters of the various foodstuffs met with in ordinary commerce, and points out the physical signs by which unwholesome food may be detected.

The first sixty pages deal chiefly with the statutory powers by virtue of which the food-supply of the community is supervised. They include a summary, with explanatory comments, of the various enactments —Public Health Act, Sale of Food and Drugs Acts, and so on—bearing upon the control of food from the inspector's point of view. Next follow chapters treating of meat, poultry, and fish. This is the most important part of the book, and the notes upon the *ante-* and *post-mortem* signs of those diseases which render flesh-food unfit for consumption, or which seriously depreciate its quality, will be especially valuable to sanitary officers who have had no veterinary experience. A subsequent chapter is allotted to fruit and vegetables, and one to milk; the rest of the book gives short descriptions of cereals, dairy products, tea, sugar, spices, and so forth. This section, though of interest to the food inspector, is of less concern to him than the foregoing, the quality of the articles mentioned being generally a matter for decision by analysis, not for condemnation at sight.

The author gives sensible advice, and his little volume should be found very useful to those for whom it is written. The only inaccuracy we have noted is suggested in the statement that "Dutch cheese is below the standard per cent. as regards fat"; this might imply that there is a legal standard, which is not the fact. C. S.

Manuale dell'Ingegnere Elettricista. By Attilio Marro. Pp. xv+689. (Milan: Ulrico Hoepli, 1905.) Price 7.50 lire.

THIS book forms one of the useful series of "Manuali Hoepli," which already comprises over 800 distinct treatises. Its aim is to give to engineers and electrical constructors most of the information and data that they are likely to require in practice. On this account it is not so much a text-book as a classified collection of rules and data; but on account of its containing a large amount of explanatory matter it lies intermediate between a treatise on electrical engineering and a pocket book of electrical rules and tables. The type being small but clear, a very large amount of useful information is collected in a small compass. The numerical data have been obtained principally from recent papers published in the journals of electrical engineering, and are collected in 115 tables. The work is illustrated with 192 cuts and is furnished with a good index. Its size well adapts it to be a handy pocket book of reference, and it is likely to prove of considerable use.

Poisonous Plants of all Countries. By A. B. Smith. Pp. xvi+88. (Bristol: J. Wright and Co., 1905.) Price 2*s*. 6*d*. net.

THE author has collected a fairly representative list of poisonous plants, which he has arranged according to the action produced and the organs affected, but there is no mention made of the part or parts of the plant which furnish the poison. The descriptions, which form the main part of the text, are sufficient where reference is made to the whole plant, but the majority are too meagre to be diagnostic. The string of vernacular names which is quoted in several cases does not serve any useful purpose, whereas beyond the mere name of the toxic principle information which is much required is not given.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Constant of Radiation as Calculated from Molecular Data.

IN NATURE, May 18, I gave a calculation of the coefficient of complete radiation at a given absolute temperature for waves of great length on principles laid down in 1900, and it appeared that the result was eight times

as great as that deduced from Planck's formula for this case. In connection with similar work of his own, Mr. Jeans (*Phil. Mag.*, July) has just pointed out that I have introduced a redundant factor 8 by counting negative as well as positive values of my integers ξ, η, ζ.

I hasten to admit the justice of this correction. But while the precise agreement of results in the case of very long waves is satisfactory so far as it goes, it does not satisfy the wish expressed in my former letter for a comparison of processes. In the application to waves that are not long, there must be some limitation on the principle of equi-partition. Is there any affinity in this respect between the ideas of Prof. Planck and those of Mr. Jeans?

Terling Place, Witham, July 7. RAYLEIGH.

Proposed Observation of Mercury during the Solar Eclipse.

DURING the eclipse of the sun on August 30 next there will be an opportunity of making a very interesting observation on the planet Mercury, to which I ask permission to direct attention.

Mercury at the time of the eclipse will be very close to the line joining the earth and sun—about 2° 54′ south and 2° 54′ preceding the sun—*i.e.* at an angular distance from the sun's centre of nearly 4° 6′. Accordingly, the illuminated part of Mercury will be an excessively thin crescent which, if Mercury have an atmosphere, will have its horns prolonged by atmospheric refraction.

If a sufficiently skilled observer is provided with a telescope upon which he can use a power of 200 without loss of definition, and mounted—probably as an alt-azimuth—so that it can be set beforehand upon Mercury, the apparent size of Mercury will be that which would be presented by a circle one-tenth of an inch across, viewed with the naked eye from a distance of ten inches.

This ought to be sufficient magnification to see whether the horns of the crescent are prolonged, and, if so, it is perhaps not impossible that the light would be sufficient to enable a spectrum of the tips of the crescent to be seen.

If the whole of this programme can be carried out, we should find out whether Mercury has an atmosphere, and possibly learn something as to the constituents of the atmosphere. G. JOHNSTONE STONEY.

30 Ledbury Road, W., July 10.

The Planet Uranus.

ASTRONOMICAL amateurs will have an excellent opportunity of identifying Uranus on about July 16 next, for the planet will be in conjunction with the star 1 Sagittarii (mag. 5·3) on the night following that date.

The position of Uranus at transit (10h. 30m.) will be :—

R.A. 18h. 5m. 58s., Dec. S. 23° 42′ 21″,

while that of the star will be (1905·5) :—

R.A. 18h. 5m. 57s., Dec. S. 23° 43′ 16″,

so that the planet will pass about 1 minute of arc north of the star. The latter may be easily picked up, as it is nearly 4° S. of the triple star μ or 13 Sagittarii (mag. 4·1).

Unfortunately, the objects will be low in altitude (15°), and the moon happens to be full on the date of conjunction.

On June 24 and July 8 I found Uranus a little fainter than the star 1 Sagittarii. I have carefully observed the planet on several nights in a 12½in. Calver reflector, powers 100 to 475. The disc appeared faint with a bluish tinge, and no belts or other markings could be detected, but the telescope is too small to deal effectively with an object of this description.

Bristol, July 9. W. F. DENNING.

The Exploration of the Atmosphere above the Atlantic.

A PLAN for systematic work of this kind, which was proposed by the writer in 1901 at the Glasgow meeting of the British Association (Report, p. 724) after he had obtained the first observations with kites flown from a Transatlantic steamer, is now being partially realised. Last summer Prof. Hergesell, on board the Prince of Monaco's steam-yacht *Princess Alice*, executed sixteen kite-flights above that part of the Atlantic bounded by Spain, the Canaries and the Azores, but without finding the expected south-west anti-trade, although a height of nearly 15,000 feet was reached (NATURE, vol. lxxi. p. 467). The present expedition, which will repeat Prof. Hergesell's investigations and continue them further south, is made possible through the cooperation of our distinguished French colleague, M. Teisserenc de Bort, whose steam-yacht *Otaria*, of 350 tons, with a speed of 11 knots, and fully equipped for aërial exploration, has just sailed from Gibraltar, and, at the joint expense of her owner and the writer, will proceed towards the equator by way of Madeira, Canary and Cape Verde Islands, making frequent soundings with kites through the trade winds and equatorial calms. By means of the self-recording instruments lifted by the kites, it is expected that there will be ascertained the thermal and hygrometric conditions of the various strata traversed, and the depth and force of the trade wind in the different latitudes. If the kites do not reach the south-west return trade, which has been observed on the Peak of Teneriffe, the vertical range of observation may be increased by liberating hydrogen balloons from Madeira and noting their drift.

Mr. Clayton, meteorologist of the Blue Hill Observatory, left Boston on June 3 to join the *Otaria* at Gibraltar. During his voyage to the Azores on the White Star liner *Romanic* he flew kites, with instruments attached, almost daily to the height of from five-eighths to three-quarters of a mile, thus securing the highest observations in mid-Atlantic, and it is interesting that this was done on June 7, the day appointed for the international observations in the upper air here at Blue Hill and in Europe. In general, the temperature was found to decrease with altitude at less than the adiabatic rate, and the relative humidity to decrease also, but in one ascent there was a rise of temperature with altitude, preceding a change of wind from west to south. A new form of folding kite was employed, and it is encouraging to learn that the heights attained were limited by the length and strength of the wire on the hand-reel, which did not permit more than one of these kites to be attached. On the two days when no flights were made, a following wind became too light on board the steamer to lift the kites, whereas, on the yacht, this condition would have been obviated by simply lying-to, or steaming against the wind.

While the cruise of the *Otaria*, which is to last only six weeks, can hardly do more than elucidate certain questions relating to the high atmosphere in the tropics, it will demonstrate the possibilities and difficulties attending the extensive survey that the writer desires to undertake, and which received the endorsement of the International Meteorological Committee at Southport in 1903.

A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, Hyde Park, Mass., U.S.A., June 26.

Ancient Antarctica.

PROF. H. F. OSBORN has said that the demonstration of "the former existence of an Antarctic continent is one of the greatest triumphs of modern science." But even if this be true, everyone must allow that it occurred a very long time ago. This is proved by the great differences that exist between the floras and faunas of the three great southern continents. These differences are much greater than those between the floras and faunas of North America and Eurasia, and consequently the land connections must have been broken up in the south long before they were in the north. We infer the former existence of an Antarctic continent from the existence of granite and foliated schists in South Victoria Land, and evidence that it was formerly connected with northern lands is found in the existence of flightless insects living there in the few patches of mosses and lichens which manage to struggle through the winter. These insects are not flightless through degeneration, but belong to an order which never possessed wings.

It is very improbable that the ancestors of these minute insects were carried or blown to where they are now found; they must have travelled to their present positions by land. That is, the Antarctic continent south of New Zealand and Patagonia must, at some time or other, have joined on to northern lands.

In the islands of the Antarctic Ocean we have further evidence of a former land connection in the earthworms belonging to the family Acanthodrilidæ, which are characteristic of Antarctic regions. A spider also lives on Bounty Islands which is closely related to one from Cape Horn. But spiders seem to have special facilities for crossing barriers, and the insects found on Bounty Islands are all related to New Zealand forms. I do not include here the evidence of the plants of the Antarctic islands, for most plants do not require that the land should be actually continuous to enable them to spread.

But if the flightless insects and the earthworms imply a former connection with northern lands, that connection must have been a very long time ago, before the spread of insects and angiospermous plants over the world, that is, not later than the Jurassic period. If there had been any land connection in Tertiary times, there would have been a much greater mixing of the animals and plants.

It is evident that the flora, and perhaps the fauna, of Antarctica were formerly much richer than at present, as is proved by the fossil plants of South Victoria Land, and it is also probable that both fauna and flora were killed off by an increasingly rigorous climate. It is not necessary to assume a former Glacial epoch for this, for higher plants and animals could hardly resist the present climate, and there is no palæontological evidence of a period of greater cold than now having ever existed in the southern hemisphere. On the contrary, the biological as well as the palæontological evidence is against the idea. For the much modified plover, Chionis, and the insects of Kerguelen Land, as well as the remarkable flora of the Antarctic islands, show that the islands could not have been covered with ice for a very long time.

The relations between the avifaunas of Australia and South Africa are much closer than exist between those of Australia and South America, and this is just what we should expect if the ancestors of the present birds had spread down from the north under the present condition of land and sea, for the land connection between Australia and South Africa is far more intimate than that between the former place and South America. But the contrary is the case with the Mammalia, some of the tortoises, snakes, frogs, some of the fresh-water fishes, a large number of insects, and the family Cryptodrilidæ of earthworms. This implies that at some former time a closer connection existed between Australia and South America than between Australia and Africa. The question is, Was this connection by means of an Antarctic continent? Or was it by a Pacific continent?

The principal objection to the southern route is that the connection between Australia and South America is shown by a number of subtropical animals—such as Osteoglossum and Ceratodus—none of which have left any trace of their passage through New Zealand. We cannot suppose that New Zealand was disconnected at the time from the Antarctic continent, for it, also, has distinct relations with South America, but for the most part by means of different animals from those which show the Australian connection. If the connection was in either the Cretaceous or the Eocene period, we might suppose that the climate was warm enough for the passage of the subtropical animals by the Antarctic route, but, if so, why are there no traces of marsupials and South American frogs in New Zealand? If, on the other hand, we suppose the ancestors of these animals to have crossed from Australia to South America by a South Pacific continent, we can understand how the subtropical forms would not have come so far south as New Zealand, while the New Zealand forms would have crossed at a higher latitude. In favour of this we have a member of the Iguanidæ in Fiji, as well as the evidence of the land shells of Polynesia, which are not a collection of waifs and strays, but form a distinct group of a very early type, which, however, has not yet been found in South America.

We still have to consider the floras and the marine faunas of the Antarctic islands. Here we see a number of birds—such as cormorants and gulls—as well as fishes and plants, which could hardly spread round the world under the present conditions of land and water. That this spreading was a comparatively late one is proved by the near relations between the species. But if there had been continuous land at the time, land animals would have spread with the marine ones. It is therefore necessary to suppose that this last spreading of species in Antarctic latitudes was by means of a number of islands. Probably this was in Pliocene times, if we may judge by the amount of differentiation which has taken place since then.

I therefore conclude that the hypothesis which best explains the phenomena is the following:—

(1) That in the Jurassic period an Antarctic continent existed which connected South America with New Zealand and South Africa.

(2) That this continent sank in the Cretaceous period, and that Antarctica has never since been connected with northern lands.

(3) That in the Cretaceous or early Eocene a Pacific continent connected New Guinea and New Zealand with Chili.

(4) That this land sank at the close of the Eocene.

(5) That in the Pliocene a number of islands existed in the Antarctic Ocean, which have since then disappeared.

F. W. HUTTON.

The British Slugs.

MR. J. W. TAYLOR has just published part ii. of his admirable "Monograph of the Land and Freshwater Mollusca of the British Isles," containing a discussion of the slugs of the genus Arion. It is a matter of interest that, notwithstanding the great amount of information gathered in recent years, the beautiful bicoloured varieties of *A. ater* appear to hold their own as truly endemic inhabitants of Britain. These are three in number, though Mr. Taylor treats the third as merely a subvariety.

(1) *Arion ater*, var. *albolateralis*, Roebuck, 1883. Back black, sides white.

(2) *Arion ater*, var *Roebucki* (*bicolour*, Roebuck, in error). Back brown, sides yellow.

(3) *Arion ater*, var. *Scharffi*, Cockerell, 1893. Back black, sides yellow.

Mr. Taylor retains the name *bicolour* for the second variety, but it is not the *bicolour* of Moquin-Tandon, as was formerly supposed, and a new name is necessary. It is appropriate to name it after Mr. Roebuck, who first made it known. These magnificent slugs are of western distribution in the British Islands, and have quite a wide range. The only evidence of their occurrence on the Continent is Scharff's statement that Simroth found specimens "similar" to var. *Roebucki* on the shores of the Baltic; and the possibility that the Norwegian var. *medius*, Jensen, may be similar to *albolateralis*, though it is very likely not even of the same species. A quite different variety of *A. ater* is the wholly black form *aterrima*, said to be especially northern and montane. According to Mr. Taylor, this is exclusively British, except that it appears to be represented in Spain and Portugal by a similar animal named *hispanicus* by Simroth. However, I had always regarded this *aterrima* variety as the one so described from France by Dumont and Mortillet (*cf. Science Gossip*, 1889, p. 212, "the pitchy black variety found in swamps"), and if it is not, the name *aterrima*, applied to it by Mr. Taylor, cannot stand. At the opposite pole of variation from *aterrima* is the brilliant red form *A. ater*, var. *coccinea* (Gistel), which is hardly ever found in England, but is abundant in the warmer and drier regions of Central Europe.

Incidentally, it may be remarked that the name *Arion hortensis*, var. *subfusca*, employed by Mr. Taylor, cannot be retained, as it is founded on *Limax subfuscus*, C. Pfr., a homonym of *L. subfuscus*, Draparnaud.

T. D. A. COCKERELL.

University of Colorado, June 26.

NOTES ON STONEHENGE.[1]

VII.—ON THE DARTMOOR AVENUES.

SOME years ago I referred in NATURE to the numerous alignments of stones in Brittany, and I was allowed by Lieut. Devoir, of the French Navy, to give some of his theodolite observations of the directions along which the stones had been set up.

The conclusion was that we were really dealing with monuments connected with the worship of the sun of the May year, a year which the recent evidence has shown to have been the first recognised after the length of the year had been determined; thus replacing the lunar unit of time which was in vogue previously, and the use of which is brought home to us by the reputed ages of Methuselah and other biblical personages, who knew no other measurer of time than the moon.

There was also evidence to the effect that in later times solstitial alignments had been added, so that the idea that we were dealing with astronomically oriented rows of stones was greatly strengthened, not to say established.

So long as the Brittany alignments were things of mystery, their origin, as well as that of the more or less similar monuments in Britain, was variously explained; they were models in stone of armies in battle array, or they represented funeral processions, to mention only two suggestions. I should add that Mr. H. Worth, who has devoted much time to their study, considers that some sepulchral interest attaches to them, though he thinks it may be argued that that was secondary, even as are interments in cathedrals and churches. About burials associated with them, of course, there is no question, for the kistvaens and cairns are there; but my observations suggest that they were added long after the avenues were built, as some cairns *block* avenues. Perhaps a careful study of the mode of burial may throw light on this point.

The equivalents of the Brittany alignments are not common in Britain; they exist in the greatest number on Dartmoor, whither I went recently to study them. The conditions on high Dartmoor are peculiar.

Blinding mists are common, and, moreover, sometimes come on almost without warning. From its conformation the land is full of streams. There are stones everywhere. What I found, therefore, as had others before me, was that as a consequence of the conditions to which I have referred, directions had been indicated by rows of stones for quite other than ceremonial purposes. Here, then, was a possible third origin. It was a matter of great importance to discriminate most carefully between these alignments, and to endeavour to sort them out. My special inquiry, of course, was to see if they, like their apparent equivalents in Brittany, could have had an astronomical origin. The first thing to do, then, was to see which might have been erected for worship or which for practical purposes.

In doing this there is no difficulty in dealing with extremes. Thus one notable line of large flat stones has been claimed by Messrs. R. N. Worth and R. Burnard as a portion of the Great Fosseway (Rowe's "Perambulation," third edition, p. 63); it has been traced for eighteen miles from beyond Hameldon nearly to Tavistock, the stones being about 2 feet thick and the road 10 feet wide.

There are two notable avenues of upright stones at Merrivale; they are in close connection with a circle, and could have had no practical use. These stones, then, we may claim as representing the opposite extreme of the Fosseway and as suggesting an astronomical, as opposed to a practical, use; the adjacent circle, of course, greatly strengthens this view.

It is between these extremes that difficulties may arise, but the verdict can, in a great many cases at all events, be settled without any very great hesitation, especially where practical or astronomical uselessness can be established. But even here care is necessary, as I shall show.

The stones now in question, originally upright, are variously called avenues, rows, alignments or parallelithons. Their study dates from 1827, when Rowe and Colonel Hamilton Smith examined those at Merrivale (Rowe, *op. cit.*, p. 31). Their number has increased with every careful study of any part of the moor, and doubtless many are still unmapped.[1] The late Mr. R. N. Worth, of Plymouth, and his son, Mr. H. Worth, have given great attention to these monuments, and the former communicated a paper on them to the Devonshire Association for the Advancement of Science in 1892 (Trans., xxv. pp. 387–417).

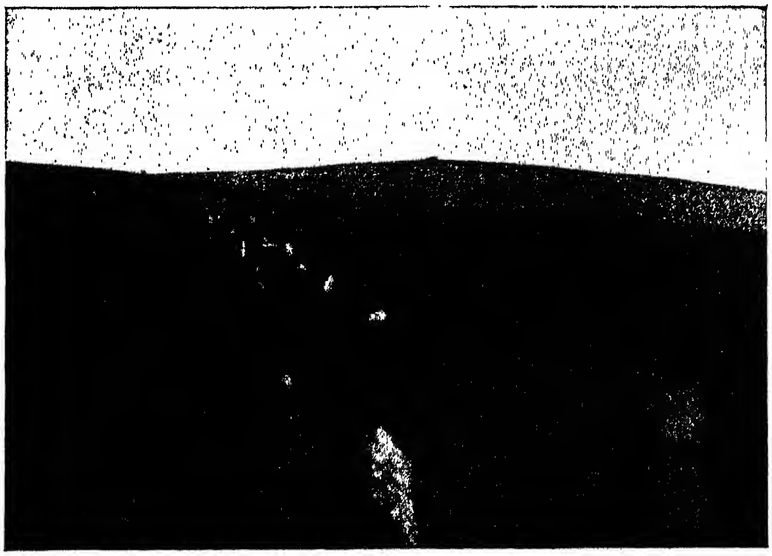


Photo. by Lady Lockyer.

FIG. 17.—The Southern Avenue at Merrivale, looking East.

A word of caution must be said before I proceed. We must not take for granted that the stone-rows are now as they left the hands of the builders. The disastrous carelessness of the Government in the matter of our national antiquities is, I am locally informed, admirably imitated by the Devonshire County and other lesser councils, and, indeed, by anybody who has a road to mend or a wall to build. On this account, any of the rows may once have been much longer and with an obvious practical use; and

[1] Continued from p. 34.

[1] Only yesterday (June 15) that excellent guide of the Chagford part of the moor, Mr. S. Perrott, showed me an avenue (Azimuth N. 20° E. true) near Hurston Ridge which is not shown in the 1-inch map.

those which now appear to be far removed from circles may once have been used for sacred processions at shrines which have disappeared.

Again, the rows of stones we are now considering must not be confounded with the "track lines" or "boundary banks" which are so numerous on Dartmoor and are represented in Wiltshire according to Sir R. C. Hoare; these serve for bounds and pathways, and for connecting and enclosing fields or houses.

Dealing, then, with stone rows or avenues, which may be single, double, or multiple; any which are very long and crooked, following several directions, are certainly not astronomical; and it is easy to see in some cases that they might have been useful guides at night or in mist in difficult country with streams to cross. This possible utility must not be judged wholly by the present conformation of the ground or the present beds of streams.

For multiple avenues it is hard to find practical uses such as the above, and we know how such avenues were used in Brittany for sun worship. Mr. Baring Gould considers there were eight rows in an avenue on Challacombe Down 528 feet long; of these only three rows remain, the others being represented by single stones here and there (Rowe, p. 33). I shall have something to say about this avenue further on.

Although, as I have said, long rows bending in various directions are not likely to have had an astronomical origin, it must not be assumed that all astronomical avenues must be *exactly* straight. This, of course, would be true for level ground, but if the avenue has to pass over ridges and furrows, the varying height of the horizon must be reckoned with, and therefore the azimuth of the avenue at any point along it.

I think it possible that in the Staldon Moor row we have the mixture of religious and practical intention at which I have before hinted. Both Mr. Lukis and Mr. Hansford Worth have studied this monument, which is two miles and a quarter long. There is a circle at the south end about 60 feet in diameter, while at its northern end there is a cairn.

Where the line starts from the circle the direction of the row is parallel to many sight-lines in Cornwall, and Arcturus would rise in the azimuth indicated. But this direction is afterwards given up for one which leads towards an important collection of hut circles, and it crosses the Erme, no doubt at the most convenient spot. More to the north it crosses another stream and the bog of Red Lake. All this is surely practical enough, although the way indicated might have been followed by the priests of the hut circles to the stone circle to prepare the morning sacrifice and go through the ritual.

But there is still another method of discrimination. If any of these avenues were used at all for purposes of worship, their azimuths should agree with those already found in connection with circles in other parts of Britain, for we need not postulate a special race with a special cult limited to Dartmoor; and in my inquiries what I have to do is to consider the general question of orientation wherever traces of it can be found. The more the evidences coincide the better it is for the argument, while variations afford valuable tests.

Now, speaking very generally (I have not yet compared all my numerous notes), in Cornwall the chief alignments from the circles there are with azimuths N. 10°–20° E. watching the rise of Arcturus, N. 24°–28° E. watching the rise of the May sun, N. 75°–82° E. watching the rise of the Pleiades. The variation in the azimuths is largely due to the different heights of the horizon towards which the sight-lines are directed.

The conclusion I have come to is that these alignments, depending upon circles and menhirs in Cornwall, are all well represented on Dartmoor associated with the avenues; and further, so far as I have learned at present, in the case of the avenues connected with circles, there are not many alignments I have not met with in connection with circles in Cornwall and elsewhere.

This is not only a *prima facie* argument in favour of the astronomical use underlying the structures, but it is against the burial theory, for certainly there must have been burials in Cornwall.

In order, therefore, to proceed with the utmost caution, I limit myself in the first instance to the above azimuths, and will begin by applying a test which should be a rigid one.

If the avenues on Dartmoor had to deal with the same practices and cults as did the circles in Cornwall, they ought to prove themselves to have been in use at *about* the same time, and from this point of view the investigation of the avenues becomes of very great importance, because of the destruction of circles and menhirs which has been going on, and is still going on, on Dartmoor. We have circles without menhirs and menhirs without circles, so that the azimuths of the avenues alone remain to give us any chance of dating the monuments if they were used in connection with sun worship. The case is far different in Cornwall, where both circles and menhirs have in many cases been spared.

On Dartmoor, where in some cases the menhirs still remain, they have been annexed as crosses or perhaps as boundary stones, and squared and initialed; hence the Ordnance surveyors have been misled, and they are not shown as ancient stones on the map. In some cases the azimuth of the stones suggests that this has been the sequence of events.

It will be seen from the above that I have not tackled a question full of pitfalls without due caution, and this care was all the more necessary as the avenues have for long been the meeting ground of the friends and foes of what Rowe calls "Druidical speculations"; even yet the war rages, and my writing and Lieut. Devoir's observing touching the similar but grander avenues of Brittany have so far been all in vain; chiefly, I think, because no discrimination has been considered possible between different uses of avenues, and because the statements made by archæologists as to their direction have been quite useless to anybody in consequence of their vagueness, and last of all because the recent work on the Brittany remains is little known.

I began my acquaintance with the Dartmoor monuments by visiting Merrivale, and the result of my inquiries there left absolutely no doubt whatever on my mind. I was armed, thanks to the kindness of Colonel Johnston, the director of the Ordnance Survey, with the 25-inch map, while Mr. Hansford Worth had been so good as to send me one showing his special survey.

The Merrivale avenues (lat. 50° 33′ 15″) are composed of two double rows, roughly with the azimuth N. 82° E.; the northern row is shorter than the other. Rowe, in his original description (1830), makes the northern 1143 feet long; they are not quite parallel, and the southern row has a distinct "kink" or change of direction in it at about the centre. The stones are mostly 2 or 3 feet high, and in each row they are about 3 feet apart; the distance between the rows is about 80 feet.

I have before pointed out that an avenue directed to the rising place of a star, if it is erected over undulating ground, cannot be straight. I may now mention another apparent paradox. If two avenues are directed to the rising place of the same star *at different times*, they cannot be parallel. It is not a little curious that absence of parallelism has been used against avenues having had an astronomical use!

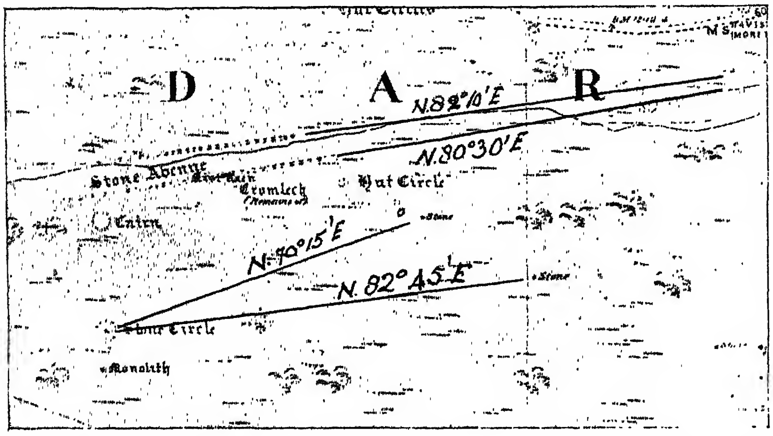


FIG. 18.—Plan, rom the Ordnance Map, showing the avenues, circle and stones at Merrivale, with their azimuths.

Both the Ordnance surveyors and Mr. Worth have shown the want of parallelism of the two avenues, and Mr. Worth has noted the kink in the southern one. The height of the horizon, as determined from my measures, is 3° 18′. The results of these inquiries, assuming the Pleiades to have been observed warning May morning, are as follows:—

Azimuth	Authority	N. Declination ° ′ ″	Date B.C.
N. 83·15 E.	Worth	6 47 47	1710
82·30	Worth	7 16 20	1630
82·10	Ordnance	7 32 0	1580
80·40	Worth	8 26 0	1420
80·30	Ordnance	8 30 0	1400

To simplify matters we may deal with the Ordnance values and neglect the small change of direction in the southern avenue. We have, then, the two dates 1580 B.C. and 1420 B.C. for the two avenues. The argument for the Pleiades is strengthened by the fact that at Athens the Hecatompedon was oriented to these stars in 1495 B.C. according to Mr. Penrose's determination of the azimuth.

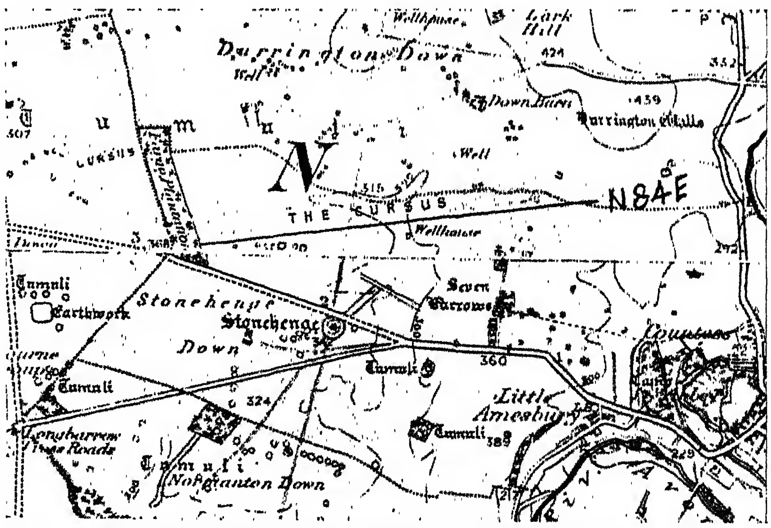


FIG. 19.—Reprint of Ordnance Map showing that the Cursus at Stonehenge is nearly parallel to the Merrivale Avenue. The azimuth is 82° and not 84° as shown in the figure.

Now this is not the first time I have referred to avenues in these notes. The azimuth of one at Stonehenge was used to fix the date at which sun worship went on there. That avenue, unlike the Dartmoor ones, was built of earth, and it is not alone. There is another nearly two miles long called the Cursus. So far, I have found no solstitial worship on Dartmoor, so there are no avenues parallel to the one at Stonehenge leading N.E. from the temple. But how about the other? *It is roughly parallel to the avenues at Merrivale, and I think, therefore, was, like them, used as a processional road, a via sacra, to watch the rising of the Pleiades.*

I said roughly parallel; its azimuth is about the same (N. 82° E. roughly); but the horizon is only about 1° high; it was therefore in use before those at Merrivale; the exact date of use must wait for theodolite values of the height of the horizon, but in the meantime we can see from the above estimates that the declination of the Pleiades was about N. 5° 28′ 30″ and the date of use 1950 B.C., that is some 300 years before the solstitial restoration.

Mr. Worth's survey gives another line of stones which is not shown in the Ordnance survey. It is undoubtedly, I think, an ancient line, although it is not shown in the Ordnance map, a clear indication of the difficulty of discriminating these avenues on land cumbered with stones in all directions. Its azimuth is N. 24° 25′ E., and the height of the horizon 5° 10′. This gives us Arcturus at the date 1860 B.C., showing that, as at the Hurlers, Arcturus was used before the Pleiades. Hence a possible *astronomical* use is evident, while this row, like the others, could have been of no *practical* use to anybody. It is interesting to note that this single row of stones is older than the double ones; this seems natural.

It is worth while to say a word as to the different treatment of the ends of the south avenue now that it seems probable that it was used to watch the rising of the Pleiades. At the east end there is what archæologists term a "blocking stone"; these observations suggest that it was really a *sighting* stone. At the west end such a stone is absent, but the final stones in the avenue are longer than the rest. This may help us to determine the true direction of the sight-lines in other avenues, and, indeed, I shall show in the sequel that it affords a criterion which in some cases is entirely in harmony with other considerations.

NORMAN LOCKYER.

SOLAR AND TERRESTRIAL CHANGES.

THE problem of the relations between sun-spots and other solar phenomena and weather has engaged the attention of men of science for many years past. The results of their investigations have not, perhaps, been so satisfactory or conclusive as were at first anticipated, but this, fortunately, has not diminished the enthusiasm of those interested in the solution of the problem. The ordinary public who were attracted by the apparent simplicity and probability of the relations suggested have undoubtedly been disappointed with the results. There has hence been a tendency for some time past to depreciate investigation in this field of science. On the other hand, the experience of the recent droughts and famines in India, Australia, and South Africa has directed attention strongly to the probable relation between variations of solar activity and the larger variations of rainfall over the earth's surface. The aqueous vapour precipitated as rain over large land areas such as India is produced by evaporation over distant oceanic areas, and is thence carried to the areas of discharge by the larger atmospheric currents. These actions are the direct results of the conversion of solar energy, and any large variation in the supply of that energy must be accompanied with, and followed by, corresponding changes in the amount of evaporation and atmospheric movement, and hence, also, of amount and distribution of rain. The determination of the relations thus indicated is not merely of value from the scientific standpoint, but has important practical bearings, as it may lead to a satisfactory method of long-period weather forecasting —a question which is largely engaging the attention of meteorologists at the present time.

Three lines of observation (and hence also of investigation) carried on at the present time furnish data for the solution of the problem. These are the observations of terrestrial magnetism, of terrestrial atmospheric meteorology, and of solar phenomena.

A large number of magnetic observatories, furnished with the most delicate and sensitive instruments, provide a continuous record of the changes of the earth's magnetic state by its action on magnetised needles at the earth's surface.

The work of meteorological observation has made great progress during the past twenty-five years. It has not only been extended and improved, but is carried on much more systematically than hitherto. Unfortunately its record is very imperfect, as it is probably not too much to say that over at least five-sixths of the earth's surface, including the greater part of the interior of Asia and Africa, and over the larger oceanic areas and the Polar regions, the amount of observation is exceedingly small and of little value for the solution of the problem. There is hence a continuous record of the meteorological changes of the earth's atmosphere over barely one-sixth of its surface. There is, moreover, no general collection and publication of the meteorological data in such a form as to give a continuous history of the larger atmospheric variations and changes in progress over even that sixth part of the earth's surface.

The third branch of observation, that of solar phenomena, has made wonderful progress during the past fifty years. Previously the telescopic examination of the sun's surface had disclosed the eleven-year periodicity of the sun-spots. Latterly the combination of the spectroscopic and telescopic observation of the sun has revealed the complexity of the changes in progress throughout the depth of its atmosphere, and of which the sun-spots are only one and a very partial expression. This field of investigation is so promising that solar observatories have been established in many countries, and a continuous record of the solar changes, so far as they are indicated by present methods of observation, is now possible by combining the data furnished by all the observatories. The work of correlating the three classes of observation has, however, not yet been commenced in a systematic manner, although the necessity is now fully recognised.

It is now generally, if not universally, admitted that the sun is practically the sole source of the energy which maintains the movements of the earth's atmosphere. It is the centre of a continuous outflow of radiant energy, a very small portion of which is intercepted and appropriated by the earth, where it is converted into other forms of energy. The investigation of the rate of this flow of energy and its time variations, the analysis of the total energy into its elements as that of a series of oscillatory movements of different periods and amplitudes or wavelengths, and the problem of its distribution in its passage through the atmosphere and at the earth's surface are each in little more than the initial stages. In some departments of the investigation, as, for example, the laws of the absorption of the solar energy during its passage through the earth's atmosphere, much work has been done, but with comparatively little result.

The appropriation of solar energy by the earth affects it mainly in two ways, first, as a whole, determining or modifying its magnetic condition, and secondly, partially, affecting the atmosphere and a thin surface layer of the solid or liquid mass. Any variation in the flow of solar energy, periodic or irregular, will theoretically give rise to corresponding changes in the earth's magnetic condition and its atmospheric movements. The determination of the relations between the three classes of variation is on the whole the most important problem in this field of inquiry into the solar energy and its variations and effects.

The first part of the problem, that is, the relation of the variations of solar energy (as manifested and measured by the observable changes in the number and extent of the sun-spots, prominences, &c.) to those of the magnetic condition of the earth shown by its action on a magnetised needle suitably suspended, is comparatively simple, as the earth appears to be similarly affected as a whole and throughout its whole mass. The variations are indicated as clearly and satisfactorily by an observatory in India or Australia as at Kew in England. There are undoubtedly local variations which may require to be eliminated in order to obtain the general variation. It has, however, been conclusively established by observations in different regions that there is a general parallelism between the amount and extent of the magnetic variation or disturbance and the number and magnitude of the sun-spots and prominences. The rule is, the larger the number of sun-spots the greater the amount of the magnetic variation and disturbance. The relation can, however, at the present stage only be considered as statistical, as it has not been established for single sun-spots. In other words, the observed outburst or sudden appearance of a single spot or prominence is not invariably accompanied by a terrestrial magnetic disturbance. Various reasons have been given for the failure of parallelism in detail. Hence all that can be inferred at the present time is that definite relations (of a statistical kind) of great importance have been obtained which more than justify the continuance of this branch of the inquiry, and make it desirable that the work of terrestrial magnetic observation and investigation, and of comparison with solar phenomena, should be maintained and if possible extended.

Numerous attempts, only very partially successful, have been made to establish similar definite relations between solar and terrestrial atmospheric variations. The South Kensington observatory has done much valuable work in this direction. It is, however, doubtful whether the results obtained by any of the investigators in this branch are generally accepted.

The reasons for this very partial success are almost self-evident, and are due to the complexity of the problems presented by the movements of the atmosphere, more especially as modified by the presence of very varying amounts of aqueous vapour, the result of the processes of evaporation and condensation. The effects of the solar variation on the earth's atmosphere are, in fact, distributed and manifested in very varying proportion between the different elements of observation, and the direct effect of a solar variation on one element may be followed by an opposite effect due to variation of another element, so that the final result may be opposite in character to the initial effect. Thus an increase of solar radiant energy would, if there were no increase of aqueous vapour amount, cloud or air movement, undoubtedly increase pressure and temperature. If these changes, however, give rise to increased vertical and horizontal movement, it is possible that as a later result pressure probably, and temperature possibly, might both be decreased below their original or normal level, and hence that the observed change might be the opposite to that of the direct effect of the original variation. Also there is another source of difficulty in this branch of the inquiry, due to the fact that in the case of some of the elements of observation a positive variation over a considerable area of the earth's surface must necessarily be accompanied with a negative variation of corresponding amount in some other region as part and parcel of the total change. The changes in these elements, taken over the earth's surface, must either be completely compensatory, as is probably the case for pressure, or partially compensatory, as is undoubtedly the case for rainfall.

It is also necessary to bear in mind that the instrumental appliances for magnetical and meteorological observations are of very different orders of exactness. Magnetic instruments, more especially those for continuous autographic registration, are of great delicacy. Meteorological instruments are, on the other hand, much less delicate, and the most important of all from certain points of view, viz. the instruments for registering the direction and rate of air movement, are especially coarse, and their individual observations are necessarily affected with large errors.

The problem of the relations between solar and terrestrial meteorological variations is hence complicated and difficult. It evidently requires for its complete solution the collection and coordination of data for the whole of the earth's surface, and the careful employment of statistical methods regulated by thorough knowledge of the physics of the atmosphere.

The difficulties of the problem are great, and explain the comparative want of success of investigators hitherto. It is, however, certain from theoretical considerations that there are definite relations, and that their determination is of great importance, equally from the scientific and the utilitarian point of view.

The observational data for a more systematic investigation are now considered by many to be sufficient, if collected, compared, and discussed as a whole, to promise more satisfactory and valid conclusions than have hitherto been obtained, and perhaps a first approximate solution. This opinion found expression fully at the meeting of the British Association at Southport in 1903. Sir Norman Lockyer, director of the Solar Physics Observatory, South Kensington, read a report giving a summary of the results of previous investigations in "Simultaneous Solar and Terrestrial Changes" to Section A of the British Association. The members of the International Meteorological Committee present at the meeting joined in the discussion, and it was decided that the time had arrived for joint and concerted action. A commission to act as a subcommittee of the International Meteorological Committee was formed to discuss meteorological observations from the point of view of their connection with magnetism and solar physics. The commission held several meetings at Cambridge in 1904 during the British Association week. Several additional members were added to the commission, which now includes the names of the leading authorities in the three associated branches of science.

The chief work of the commission at Cambridge was to lay down principles for the selection of the data required for comparison, and to arrange for the choice of stations and observatories from which it would be desirable to obtain data prior to entering into communication with the various organisations that it would be necessary to ask for assistance in the collection of data.

It has been arranged that a meeting of the commission shall be held in connection with the meeting of the International Meteorological Committee at Innsbruck in September. A number of important matters will there be considered. Amongst these are the final selection of magnetic and meteorological observatories from which data are to be collected, the mode of publication of the data received by the commission, and probably, also, of the methods to be employed in the work of comparison and discussion of the data. Hofrath Prof. Julius Hann has suggested for consideration a method of determining the variation of temperature during a sun-spot period. This will, it is hoped, lead to an interesting discussion on the methods of investigation most suited and appropriate for the determination of the relations between solar and terrestrial phenomena.

THE PROPOSED COLLEGE OF APPLIED SCIENCE.

THE appearance of the preliminary report of the Departmental Committee on the Royal College of Science and Royal School of Mines, which was published in our issue of last week, brings us an important step nearer the realisation of an object after which men of science have long striven; the provision, that is, of a great metropolitan college—liberally endowed, handsomely housed, adequately equipped, and generously staffed—designed amply to supply that higher technical instruction for which there has been little provision hitherto, but upon which our well-being as a commercial and manufacturing nation ultimately depends.

The report shows that the committee has been engaged wisely in determining what precisely the existing facilities for instruction in applied science are, and in gathering the information necessary to decide what the new college should supply in addition to these, so as to place London, as the centre of the Empire, in a condition to compare educationally with Berlin, for example, or with many great American cities. It is unnecessary here to recapitulate the recommendations of the committee, but the special wisdom of

one or two of its conclusions cannot be insisted upon too earnestly or too often.

The new institution must be in no sense parochial, nor must it be allowed to become merely metropolitan. From the beginning the design must be to give the college an Imperial character, and every means must be taken to encourage young men possessed of the necessary qualifications, in whatever part of the Empire they may be, to attend its courses and avail themselves of the means offered by it of becoming familiar with recent advances in technology and with any branch of applied science in its highest form.

The new institution must not be allowed to become merely another technical college on a larger scale—of technical institutes we have many already. The "duly qualified students" referred to by the committee should have already received collegiate training, and have taken a degree. To quote the report:—"Admission to these higher courses should be restricted to duly qualified students who, it is hoped, would be attracted from all parts of the Empire." The public must be taught to estimate the success of the new institution, not by the number of its roll-call, but by the number of expert engineers of all kinds, of original technical chemists, of machine designers, and so on, who are trained within its portals.

But besides being able to supply the future manufacturer with the very latest results from the research laboratories of workers outside its walls, the new institution, if it is to be really successful, must itself be an active centre of research. As the report says:—"It is of the first importance that there should be no divorce between teaching and research in technology on the one hand and in pure science on the other," and the new college must be as notable for its success in research in technology as for the ability possessed by its staff to acquaint the student with the findings of recent scientific work. Unless from the beginning the student feels he is under the influence of professors who are not only familiar with all the conditions of actual manufacture in its most successful form, but who are responsible also for the improvements in technical processes which win success, the institution will neither do the work expected of it nor win the confidence of our manufacturing magnates and merchant princes. Only that science—whether pure or applied—really lives which grows continually, and such growth without patient research is impossible. The new institution must above all things be the growing point of our national system of technical instruction.

To fulfil these two functions—on which the report rightly lays very great emphasis—the staff of the Imperial college must be both numerous and the best available. In other words, the institution must of necessity be a costly one, judged, that is, from the standard adopted previously in this country for estimating educational expenses. But if properly selected such a staff will very soon show, by the results accomplished, that generous expenditure on higher education is a remunerative form of national expenditure. It is gratifying to find from the report that there is every prospect that a sufficient revenue will be eventually forthcoming, in the provision of which funds the State will take its part. We learn from the *Times* that the Government has decided to allocate 20,000*l.* a year to the college out of the Treasury subsidy for the maintenance of the Royal College of Science and the Royal School of Mines, and that an intimation to this effect has been made by the Chancellor of the Exchequer to Mr. Haldane, the chairman of the Departmental Committee.

There is every reason to hope that London will ere long have at South Kensington a college of applied science which will be as much admired as the similar institution at Charlottenburg, and prove as useful to the industries of this country as the Berlin college has to those of Germany.

NOTES.

As the new buildings of the University of Sheffield were opened by the King at the time the present issue of NATURE was being prepared for press, we cannot do more than record the fact, reserving a description of the buildings and an account of the opening ceremony for a subsequent number.

THE annual meeting of the Imperial Cancer Research Fund was held on July 5 at Marlborough House, the Prince of Wales presiding. Sir William Church moved the adoption of the secretary's, superintendent's, and treasurer's reports, which was seconded by Mr. Tweedy. Mr. Henry Morris moved that the best thanks of the meeting be given to His Royal Highness for presiding, which was carried with acclamation. The Prince of Wales in reply alluded to the researches which had been carried out in the laboratories of the fund, and expressed his satisfaction that the committee had again secured the services of Sir William Church as chairman of the executive committee.

THE summer show of the Royal Horticultural Society was opened on Tuesday last, and will remain open until this evening. It is being held for the first time in the grounds of Chelsea Hospital. The society appears to be in a very flourishing condition, more than 1000 new fellows having been added within the last few months.

THE Albert medal of the Society of Arts for 1905 was, on Wednesday, July 5, at Marlborough House, presented by the Prince of Wales, as president of the society, to Lord Rayleigh "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

THE French Association for the Advancement of Science will this year meet at Cherbourg. The session will extend from August 3 to 10.

THE summer meeting of the Institution of Naval Architects will take place on July 19, 20, and 21 in the hall of the Society of Arts. The following papers will be read and discussed:—"Tactics and Strategy at the Time of Trafalgar," by Admiral Sir Cyprian Bridge, G.C.B.; "The Ships of the Royal Navy as they Existed at the Time of Trafalgar," by Sir Philip Watts, K.C.B., F.R.S., vice-president; "The Classification of Merchant Shipping, illustrated by a Short History of Lloyd's Register," by H. J. Cornish; "Experiments with Models of Constant Length and Form of Cross Sections, but with varying Breadths and Draughts," by Lieut.-Col. B. Rota; "Experiments on the Effect of Depth of Water on Speed, having Special Reference to Destroyers recently Built," by H. Yarrow; "Deductions from Recent and Former Experiments on the Influence of the Depth of Water on Speed," by W. W. Marriner; "The Failure of some large Boiler Plates," by J. T. Milton; and "A Comparison of the Performances of Turbines and Reciprocating Engines in the Midland Railway Company's Steamers," by W. Gray.

The London congress of the Royal Institute of Public Health will be held from Wednesday next, July 19, to Tuesday, July 25, under the presidency of Sir James Crichton Browne. The meetings will take place at King's College, Strand, and at the Polytechnic, Regent Street. In connection with the congress there will be an exhibition of sanitary and educational appliances at the Regent Street Polytechnic, and this will remain open until July 28.

The *British Medical Journal* announces that a tuberculosis exhibition, arranged under the auspices of the National Association for the Study and Prevention of Tuberculosis, and of the Committee on the Prevention of Tuberculosis of the Charity Organisation Society, will be held in New York in November next. The object of the exhibition is the education of the people. In addition to exhibits illustrating different phases of the tuberculosis problem, and especially the treatment of the disease, popular lectures will be delivered by specialists.

The Long Fox memorial lecture for this year will, says the *Lancet*, be delivered in November by Dr. E. Markham Skerritt.

M. Curie was last week elected a member of the Paris Academy of Sciences.

The Mary Kingsley medal of the Liverpool School of Tropical Medicine has been awarded to Dr. Laveran, of the Pasteur Institute, Sir Patrick Manson, K.C.M.G., F.R.S., and Col. Sir D. Bruce, K.C.B., F.R.S.

Lord Kelvin and Sir William Christie, Astronomer Royal, were at the final meeting of the present session of the Optical Society made honorary members of the society.

It is stated in *Science* that Prof. William Osler has been made honorary professor of medicine at the Johns Hopkins University.

The president of the Board of Agriculture (the Right Hon. Ailwyn E. Fellowes) will distribute the diplomas and prizes at the South-eastern Agricultural College, Wye, on Friday, July 21.

We learn from the Royal Society that as an adjunct to the International Laboratory of Physiology on Monte Rosa, a lower laboratory, with a hostel, has been established at Col d'Olen. This lower laboratory is mainly intended for biological research, but it is understood that provision has also been made for the study of terrestrial physics and meteorology. The Royal Society has the permanent nomination to two posts, each of which includes a living room in the hostel, a bench in the laboratory, and the use of apparatus; but the expenses of living and of special researches must be borne by the investigators. The laboratory is especially connected with the University of Turin, but is under the immediate direction of a committee. Applications for nominations to the two posts referred to above may be addressed to the secretaries of the Royal Society, Burlington House, London, W.

A Reuter telegram from Florence states that the instruments of the Delle Quercie Observatory of that place recorded on Sunday last severe earthquake shocks as taking place in a distant country.

The death is announced from Belgium of M. Elisée Reclus, the French geographer, in his seventy-sixth year. At the University of Berlin he studied under the great geographer Karl Ritter. Having in 1851, because of his political opinions, to leave France, he travelled for six years, visiting England, Ireland, North America, Central America, and Colombia. Returning to his native country in 1857, he contributed numerous articles on his travels to periodical literature, and published a small volume entitled "Voyage à la Sierra-Nevada de Sainte Marthe." Later he wrote two books dealing respectively with the earth and the ocean. He began at Clarens, on the Lake of Geneva, the work of his life—the "Nouvelle Géographie Universelle," the first volume of which appeared in 1876. The work was issued in parts, and was completed in 1894, the whole occupying nineteen volumes. On the conclusion of this great task Reclus began another work dealing with the historical side of human development, *i.e.* with history as influenced by geographical conditions. He left this book, it is said, in a complete state, ready for publication.

The death of Prof. Hermann Northnagel, of Vienna, in his sixty-fifth year, is announced. He made many contributions to medical literature, and by these and his discoveries in regard to heart action he was well known in the medical profession. Prof. Northnagel was a corresponding member of the Royal Medical Society of this country.

Many of our readers will be glad to learn that steps are being taken to raise a memorial to the late Prof. G. B. Howes, F.R.S. In the circular letter on the subject which has reached us it is pointed out that his death was probably due most of all to overstrain occasioned by his unsparing zeal in the acquisition of full and accurate knowledge and the undeviating readiness with which he imparted the fruits of his genius and learning, not only to his regular pupils, but to every association which asked for his assistance. It is proposed that the memorial shall take the form of an endowment fund for his widow and daughter. Subscriptions should be sent as soon as possible to the honorary treasurer, Mr. Frank Crisp, 17 Throgmorton Avenue, E.C., marked on the cover "Howes Memorial Fund." We trust there will be a generous response to the appeal.

A meeting of members of the Essex Field Club took place, by invitation of Lady Warwick, at Easton Lodge on Saturday last to inaugurate a photographic and pictorial survey and record of Essex. The object of the scheme is to make a permanent collection of photographs and other pictures of objects of interest, also maps, plans, and other documents, in order to give a comprehensive survey and record of all that is valuable and representative of Essex. The pictures, plans, &c., will be deposited and placed on view in the museum of the Essex Field Club at West Ham, and it is hoped that all the photographic societies and unattached photographers of the country will assist the committee in its work that its object may be attained.

We are indebted to a correspondent for a copy of a supplement to the Selangor *Government Gazette*, dated April 28, containing a report from the district surgeon of Klang on "the progress of anti-malarial measures carried out at Klang and Port Swettenham," in the Federated Malay States, during the past four years, from which we learn that in 1901 malaria was very prevalent both at Klang and Port Swettenham, there being much swampy ground in which, as well as in wells, ditches, and pools, Anopheles were found breeding. Active work was undertaken in the shape of tree felling, the clearing of undergrowth, the filling up of abandoned drains, the inauguration of a system of drains to carry off and prevent

the stagnation of rain water, the notification, and if necessary the removal to hospital, of cases of malaria, and the use of kerosene and the administration of quinine, with such marked success that at the present time malaria has practically, if not absolutely, disappeared from the places where the aforesaid measures have been carried out, while the remainder of the district remains much as it was. The report is a striking testimony to the value of the discovery by Major Ronald Ross.

A COMMITTEE appointed some years ago by the laboratory section of the American Public Health Association has recently issued its report on standard methods of water analysis. The committee in formulating the report has ascertained in a comprehensive manner the views of American analysts in regard to the bacteriological, chemical, physical, and microscopical examinations of water, and much cooperative work has been done in connection with the differentiation of species of bacteria. The need for greater uniformity in water analysis methods is universally recognised, and in the further standardisation of analytical and bacteriological methods in this country regard should be had to the report of the American committee. The part dealing with the identification of species of bacteria would appear to be specially valuable. The report is reprinted from the *Journal of Infectious Diseases* (May).

IN connection with the Agricultural Education and Forestry Exhibition at the recent show of the Royal Agricultural Society there was a section devoted to meteorology, organised by the Royal Meteorological Society. One feature was a typical climatological station with all the necessary instruments; another was an exhibition of diagrams, maps, photographs, &c., illustrating the effect of weather upon agriculture. Barometers, thermometers, rain gauges, sunshine recorders, &c., were also shown, and an address was given each day by Mr. W. Marriott on meteorology in relation to agriculture.

WE have received from the meteorological reporter to the Government of India (Dr. G. T. Walker) the *Monthly Weather Review* for November, 1904, and the *Annual Summary* for 1903. In the *Monthly Review* the data are presented from two different points of view:—(1) the prevalence and spread of diseases, and (2) their connection with agricultural questions. For this purpose India has been divided into two large groups of divisions, from what may be termed the medical and agricultural standpoints. The vastness of the area, and the number of tables that the discussions necessitate, are somewhat bewildering. The *Annual Summary*, however, completes the discussion, and the aggregate data are presented in an elaborate but clear and able manner. From the agricultural standpoint, India is divided into 57 meteorological districts; the tables show, for each element, the departures of the monthly and annual mean values for 1903 from the averages of past years, and the leading features are clearly illustrated by a series of carefully prepared charts.

THE English titles of the *Journal of the Meteorological Society of Japan* for May show that it contains several interesting articles, *e.g.* on the earthquake of April 15, the hot wind at Taito in Formosa, and others. Mr. T. Okada contributes a note in English on the relation between the pulse-rate and atmospheric pressure. The author quotes a table by Prof. Clayton, who made an ascent of Pike's Peak in 1901 by means of the railway, and therefore without exertion, and Mr. Okada has calculated the atmospheric pressure at each station up to 4313 metres, from Hann's simplified barometric formula. A glance at the table shows that the pulse-rate regularly increases with decrease of atmospheric pressure, and he gives a simple equation by the use of which the actual and calculated values exactly agree. This formula shows that a decrease of 9 mm. of pressure causes an increase of one beat of the heart per minute.

WE have received a copy of the report and results of observations for the year 1904 at the Fernley Observatory, Southport. The work carried on at this institution is of considerable importance; the observatory represents the coast district of the north-west of England, between Liverpool and Fleetwood, while somewhat to the east is the inland observatory of Stonyhurst. All these stations, except, perhaps, Fleetwood, are equipped with complete self-recording instruments. The Southport Observatory undertakes, in addition to the usual work of a first order station, considerable experimental work connected with rainfall, evaporation, wind, &c., at various subordinate stations in its vicinity. It also publishes a useful table of comparative climatological statistics at health resorts and large towns. The tables show that at Southport the year 1904 was very dry, the rainfall being 7·4 inches below the average. The maximum shade temperature was 82°·4, on July 11, and the minimum 22°·0, on November 27; the lowest radiation temperature was 13°·4, on February 29. The director is Mr. J. Baxendell, meteorologist to the Southport Corporation, and the chief assistant Mr. F. L. Halliwell, who, in connection with Mr. Baxendell and Mr. W. H. Dines, has invented several large sensitive recording instruments which are now adopted at various important stations.

THE Board of Agriculture and Fisheries has received, through the Foreign Office, a copy of a despatch from the British Consul at Munich reporting that 200,000 eggs of a new kind of whitefish (*Coregonus Albula*) of the Salmonidæ family, imported from Lake Peipus, in Russia, were hatched last year with excellent results at the fish-breeding station at Starnberg, near Munich. It is the intention of the Bavarian Fisheries Society, under which the experiments have taken place, to continue trials for five consecutive years to the same extent as hitherto, in the hope that the fish first placed in the different lakes may have spawned by then.

THE *Bulletin of the Johns Hopkins Hospital* for May (xvi., No. 170) contains papers on various medical subjects and on cancer, &c., in bitches. Dr. Hemmeter, in an article of considerable interest, discusses the history of the discovery of the circulation of the blood. He remarks that no less than six individuals have been credited with this discovery—Servetus by the Spaniards, Colombus, Ruini, and Cesalpinus by the Italians, Harvey by the English, and Rabelais by the French. He then proceeds critically to survey the evidence for and against the claims of these, and also of Galen, Malpighi, and others whose anatomical discoveries were almost necessarily precursors of the conception of the blood circulation. Dr. Hemmeter finally concludes that "the discovery of the circulation of the blood was the work of almost a millennium from Aristotle and Galen to Harvey, but the one who first logically drew true consequences out of hundreds of years of preceding work, and upon whose broad intellectual shoulders all subsequent investigations rested, was William Harvey; and to-day, 328 years after his birth, we may side without reservation with the words of Bartholin: "At Harveyo omnes applaudunt circulationis auctori."

ANOTHER mounted specimen of the great auk has just been sold to a Continental museum by Messrs. Rowland Ward for 400*l*. There are, it is said, practically seventy known specimens, most of which are in State museums.

EXPERIMENTAL work for the purpose of protecting the sugar-growing industry in the Sandwich Islands has been undertaken by the new owners of the group with characteristic energy, and we have before us the first issue of Entomological Bulletins published at Honolulu on behalf of the Experiment Station of the Hawaiian Sugar Planters' Association. The present part is the first instalment of a series to be devoted to the homopterous insects commonly known as leaf-heppers (jumping relatives of the ordinary aphides, or plant lice) and their enemies, and treats of the minute parasites known as Dryinidæ, by which these pests are themselves attacked. Attempts have been made to introduce foreign dryinids into Hawaii in order that they should assist in keeping down the leaf-heppers, but at present with only partial success, owing to the fact that some of the introduced kinds do not prey on these insects. Any leaf-hepper attacked by a dryinid may be reckoned as good as dead, for even the contents of its head and eyes are mercilessly sucked dry by its uninvited "guest." The truth of the old rhyme about "little fleas and lesser fleas" is, however, forcibly emphasised in the case of these parasites, which are in turn attacked by what our American friends are pleased to call hyperparasites. "How hardly the dryinid parasites," writes Mr. R. C. L. Perkins, the author of the paper and director of the experiment station, "are at times pressed by their various hyperparasites, we often observed. To cite one instance, from about fifty cocoons of several species of parasites obtained near Cairns, one solitary male alone emerged, all the rest being hyperparasitised, and similar observations were made in several localities."

DR. WILLIS's annual report of the Royal Botanic Gardens, Peradeniya, Ceylon, for 1904 is chiefly devoted to the work connected with investigations in economic botany. As a new departure, the formation of a cotton experiment station in the dry region of north-central Ceylon, supplied with water from irrigation tanks, is of primary importance. The difficulty of clearing the land was enhanced by scarcity of coolie labour, but the soil is excellent, and the situation seems to be well suited to the production of Sea Island cotton; rubber is also being experimentally cultivated in this region. In connection with rubber, the checking of the canker disease observed on two Hevea plantations and the high values obtained for some samples of Castilloa rubber are of interest.

MR. E. P. STEBBING contributes a note to the *Indian Forester* (May) on the satisfactory results which have been obtained by soaking bamboos in crude Burma petroleum in order to keep off the boring beetles, species of Dinoderus known as shot-borers. The article by Mr. G. H. Myers, a member of the Bureau of Forestry, on "Forestry Education in the United States," is noteworthy as indicating the aspirations which stimulate this and similar departments. The importance of practical training and of a knowledge of American requirements is emphasised.

AN hereditary abnormality in the human hand and foot and its relation to Mendelism form the subject of an article published in the papers of the Peabody Museum of American Archæology and Ethnology (vol. iii., No. 3). The abnormality in question came under the notice of the author, Dr. W. C. Farabee, some years ago in Pennsylvania, and consists in the suppression of one phalange, or joint, in each of the fingers and toes, with the exception of the thumb and great toe, which were abnormally shortened. The whole hand was extremely short and "podgy," and this feature was associated with shortness of bodily stature. Thirty-seven persons, all related, were affected with the malformation, which was inherited in accordance with Mendel's law for five generations. Although a tradition that every other child in the family had short fingers did not prove to be exactly true, yet almost precisely half the number of offspring displayed the abnormality. In one instance a regular alternation of normal and abnormal individuals continued until the eighth child. The total number of offspring descended from the original abnormal individuals is 69, of whom 33 are normal and 36 abnormal, distributed as follows:—in second generation, 4 normals and 4 abnormals; in third, 5 and 7; in fourth, 7 and 9; and in fifth, 17 and 16. The case affords strong confirmation of the general truth of the Mendelian doctrine.

THE general report of the Geological Survey of India drawn up by the director, Mr. T. H. Holland, F.R.S., shows that during the past year much valuable work has been done, and that results of scientific interest as well as of immediate economic importance have been obtained. Among advances of unusual scientific interest is the discovery of a new series of the remarkable family of elæolite-syenites near Kishengarh, in Rajputana. In economic work the department has kept in touch with the numerous developments of private enterprise in the mining of coal, gold, manganese ore and salt, and has demonstrated the existence of iron ores of industrial value. An interesting discovery is that India possesses a possibly valuable asset in the deposits of laterite, which cover considerable areas in the peninsula and in Burma, as it is shown that laterite often exhibits the essential characters of bauxite. The subject is dealt with exhaustively in the *Records of the Geological Survey of India* (vol. xxxii., part ii.) by Mr. Holland, who gives analyses of the best samples which have so far been tested. These laterites or bauxites were collected in the Madras Presidency, in the Central Provinces, in Central India, in Bengal, and in Bombay, and the percentages of alumina reach as high as 67·88. In the same issue of the Records Mr. Holland publishes returns of the Indian imports and exports of mineral products in 1904. The export of 154,880 tons of manganese ore is a remarkable feature, and the rapid increase in the export of Indian mineral oil is also noteworthy.

WE have received from the Peruvian Government copies of Bulletins Nos. 22 and 23 issued by the Corps of Mining Engineers. The former is a monograph on the mineral resources of the province of Otuzco, by Mr. F. Malaga Santolaya. The province contains rich deposits of gold and silver ores and coal of good quality, as well as ores of copper, lead, manganese, and antimony. The second bulletin is a report of a commission on the Cerro de Pasco mines, signed by the chairman, Mr. C. E. Velarde. It contains a useful summary of the Peruvian mining law and a detailed description of the Cerro de Pasco deposit, originally worked as a silver mine, but now with increasing depth yielding chiefly copper ore.

THE Sociological Society has issued a pamphlet containing an address by Dr. James Bryce on the aims and programme of the society, together with the first annual report of the council and a list of members. The report outlines the circumstances attending the inauguration of the society, and enumerates the aims which it has in view. A brief account of each of the meetings held during the

year with which the report is concerned is given, and a statement of accounts supplied. Dr. Bryce points out in his address that the members of the society may be divided into three classes, viz. those who devote themselves specially and scientifically to the business of research in all those lines of inquiry which concern man as a social being; those interested in sociology as educated and intelligent men; and practical men who are not able to devote themselves entirely to scientific study, but have to deal with sociological problems in the course of their daily life.

THE first number of a new periodical devoted to birds has just made its appearance at Cape Town. It is called the *Journal of the South African Ornithologists' Union*, and is the organ of the association recently formed under that name. Besides information relative to the new union and reports upon the proceedings of its first meetings, this number contains original articles upon South African birds by Major Sparrow, Mr. F. J. Ellemor, Mr. G. C. Shortridge, and Mr. A. Roberts. The journal is edited by Mr. W. L. Sclater (the president of the union), Dr. Gunning, and Mr. Bucknill, and will appear at irregular intervals, "when sufficient matter has been received."

MANY inquiries having been made for part ii. of the *Museum Boltenianum*, 1798 (which relates to Mollusca, and is very scarce), it has been decided to reproduce a few copies by photographic fascimile from the Crosse copy now in the British Museum (Natural History), and to sell the same at 2*l*. per copy if a sufficient number of subscribers be forthcoming. The work, if issued, will be produced under the supervision of Mr. F. W. Reader. Those wishing to subscribe should apply to Mr. E. R. Sykes, 3 Gray's Inn Place, Gray's Inn, London.

THE *Journal of the Royal Sanitary Institute* (vol. xxvi., No. 6) is mainly devoted to housing problems. Mr. Turton introduces a discussion on re-housing tenants dispossessed from insanitary property, Dr. Louis Parkes a second on housing in mansions let as flats, and Dr. Robertson a third on certain aspects of the housing problem.

THE *Psychological Bulletin* (vol. ii., No. 6) contains a report of the proceedings of the north central section of the American Psychological Association, a paper by Raymond Dodge on the illusion of clear vision during eye movements, various reviews, notes, &c.

A SECOND edition of the "Key to the Classifications of the Patent Specifications of France, Germany, Austria, Norway, Denmark, Sweden, and Switzerland in the Library of the Patent Office" has now been published at the Patent Office. The price of the "Key" is 6*d*.

MR. JOHN MURRAY has just issued the ninth edition of Mr. Edward Whymper's guide to "The Valley of Zermatt and the Matterhorn," and the tenth edition of his guide to "Chamonix and the Range of Mont Blanc." The price of each volume is three shillings net.

WE have received from Messrs. Hurst and Blackett a copy of a map of Lhasa drawn to a scale of 4 inches to a mile. The map is based on the survey in 1904 of Captain C. H. D. Ryder and Captain H. M. Cowie, with a few additions by Mr. Perceval Landon.

THE first of a series of illustrated papers by F. J. Sprague on "The Electric Railway" appears in the *Century Magazine* for July; it gives many interesting particulars of the early experiments made in electric traction.

THE articles contained in the *Bulletin of the Johns Hopkins Hospital* for June (vol. xvi., No. 171) are all of considerable medical interest, and comprise papers on the ætiology and pathogenesis of pernicious anæmia, by Dr. Bunting, on recurrent phlebitis, by Dr. Briggs, on heart block in mammals, by Dr. Erlanger, &c.

MESSRS. GURNEY AND JACKSON announce the preparation in three volumes of a translation by Dr. C. A. Keane of Lunge's "Technical Methods of Chemical Analysis."

WE are asked to state that Mr. C. S. Sargent's "Manual of the Trees of North America (exclusive of Mexico)," which was reviewed in our issue for June 29 (see p. 197), is published in England by Messrs. Archibald Constable and Co., Ltd., 16 James Street, Haymarket, and that its price is 25*s*. net.

OUR ASTRONOMICAL COLUMN.

JULY AND AUGUST METEORS.—We have now nearly arrived at what is the most interesting period of the year for the meteoric observer. With skies often clear, with the air at an agreeable temperature, and with meteors visible in more than usual abundance, success is promisingly offered to everyone who practically enters upon the study of this important and complicated branch of astronomy.

In the previous months of May and June, with their strong twilight and a scarcity of meteors, there has been no special inducement to observers, but after the third week in July the nights will become perceptibly darker, early Perseids will begin to manifest themselves, and many Aquarids will probably appear towards the close of the month from a radiant at 339°–10°. Active showers in Sagittarius, Pegasus, Draco, Cygnus, Cepheus, Andromeda, and Cassiopeia will also be observed, but the radiant points will be more remarkable for their variety and number than for striking activity in individual cases.

It is an interesting feature in observations at this time of the year to watch the Perseids from their earliest arrivals (about July 15) to their most belated apparitions (about August 21), and to trace the motion of the radiant point towards the E.N.E. In the following table the position of the radiant is given for every third night:—

Date	Radiant α δ	Date	Radiant α δ
July 18	18°·0+50°·1	Aug. 5	37°6+55°·7
,, 21	20·8+51·1	,, 8	41·5+56·5
,, 24	23·8+52·2	,, 11	45·7+57·1
,, 27	27·1+53·2	,, 14	50·0+57·7
,, 30	30·5+54·1	,, 17	54·4+58·2
Aug. 2	33·9+55·0	,, 20	58·9+58·7

Moonlight will not much interfere with observation during the period from July 25 to August 9. At the time of the Perseid maximum (either on the morning of August 12 or 13) the moon will set as follows:—

	h. m.
Thursday, August 10	12 52
Friday, August 11	13 45
Saturday, August 12	14 45

The moon will be increasingly gibbous, and though many meteors will doubtless be exhibited before moonset, it will be very advisable to count the number visible in the dark sky after our satellite has gone down, and particularly on the last two dates mentioned above, as the maximum is likely to occur between 2h. and 3h. 30m. a.m. when the radiant is high.

To give anything like a comprehensive list of the radiant points visible in July and August would require a large space, and is, moreover, unnecessary, a pretty complete summary of them having been published in *Astronomische Nachrichten*, No. 3874, for 1903 June 3.

THE FORMATION OF THE MARTIAN SNOW-CAPS.—A short note communicated by Prof. W. H. Pickering to No. 6, vol. xiii., of *Popular Astronomy* states that on examin-

ing a number of photographs of Mars, which were secured with the 11-inch Draper telescope during the period March 31 to April 30, it was seen that no snow-caps properly so-called appeared until April 23. The photograph of March 31 showed clouds on both the terminator and the limb, but no polar caps. On April 23 a clearly visible and extensive light area appeared at the southern pole, but was not bright enough for snow, rather resembling an extensive region of clouds. A very small light area appeared near to the northern pole on April 15, but was only seen with difficulty. A visual examination with a 24-inch reflector revealed the southern polar cap on April 30 as extending far towards the north in long. 340°.

Prof. Pickering thinks that when the clouds disperse snow will probably be revealed lying in their place. He also contends that the observed seasonal colour-changes from brown to green on such features as the Mare Erythræum is the surest evidence of the existence of vegetation on Mars.

RECENT OBSERVATION OF EROS.—From an equatorial observation of Eros on June 12, in which the planet's position was referred to that of δ Capricorni, Prof. Millosevich determined the following position:—

(1905 June 12d. 14h. 32m. 24s. M.T. Rome).
α (app.) = 21h. 48m. 41·74s. δ (app.) = −16° 41′ 35″·3
(*Astronomische Nachrichten*, No. 4029.)

STANDARD TIME IN VARIOUS COUNTRIES.—An interesting and useful summary of the present status of the use of standard time the world over is given in appendix iv., vol. iv., of the *Publications of the U.S. Naval Observatory*. The director of the observatory, Rear-Admiral Chester, has prepared various tables in which he shows the relation of the standard time employed in each country, state, or colony, to the meridians of Greenwich and Washington. In the first table is given a summary of nations that use standard time, and it shows that, of the thirty-six nations specifically mentioned, twenty employ Greenwich time as the basis of their systems. The areas and population concerned in these twenty nations form a very large majority of the totals, and of the remaining sixteen no two agree. This Mr. Chester regards as a powerful argument in favour of the adoption of a universal time system.

Other tables show in detail the present status of the time systems employed in a large number of localities, and enumerate the dividing lines separating those contiguous areas in which different standards are in use.

HARVARD COLLEGE OBSERVATORY ANNUAL REPORT.—In the forty-ninth annual report of the Harvard College Observatory Prof. E. C. Pickering, dealing with the year ending September 30, 1904, gives a brief outline of the progress made in each of the many and various researches which are being carried out at that observatory.

Variable stars and asteroids were photometrically observed, with the polarising photometer, by Prof. Wendell, who, *inter alia*, found that the asteroid [7] Iris varies about one-quarter of a magnitude in a period of 6h. 12m. The measurement of all the Durchmusterung stars in zones 10′ wide at intervals of 5° was continued with the 12-inch meridian photometer, and the observations of many of the zones are now practically complete.

543 photographs taken with the 11-inch Draper telescope brought the total number secured with this instrument up to 15,030, and 1116 photographs were secured with the 8-inch Draper telescope, raising the total up to date to 32,094. It is proposed to extend this work to the spectra of the fainter stars by giving exposures of sixty minutes' duration and using only one prism. Many objects having peculiar spectra were discovered by Mrs. Fleming during the examination of the Draper photographs.

The Boyden and Bruce telescopes were employed continuously, and from the examination of the long-exposure chart plates Prof. Frost discovered many new nebulæ, &c., including 203 nebulæ in Virgo where the Dreyer (N.G.C.) catalogue mentions only 58.

The meteorological observations were continued at the Blue Hill Observatory, kites being employed on fourteen occasions. The average maximum height reached by the kites was 7750 feet above sea level, the maximum altitude attained on one occasion being 14,660 feet.

THE ACADEMIC SIDE OF TECHNICAL TRAINING.[1]

IT is not so very long ago that engineers, at any rate, became willing to recognise that technical training had an academic side at all. Almost the first, and still undoubtedly the greatest, representative of the academic side of our profession was the late W. J. Macquorn Rankine, who, after eighteen years of practical engineering experience, became professor of engineering in Glasgow in 1855, and held the chair until his death in 1872, and some of whose pupils have occupied, and now occupy, very high positions in the profession for which he did so much. Perhaps it may be said that Rankine was by nature rather a physicist dealing with engineering problems than an engineer (in spite of his love for the "three-foot rule"[2]) dealing with engineering problems. But only those of us who have had occasion carefully to study his work from the point of view of trying to teach subjects similar to his can ever know what an extraordinary physicist he was. But up to the years 1870 and 1880, Rankine's pupils and their contemporaries were not yet old enough to influence the body of the engineering profession, and there still existed a pronounced dislike on the part of an enormous number of engineers to anything academic, a dislike which can hardly be realised now by those who see the various professional bodies vieing with one another in their endeavours to ensure that their members shall have a proper and complete scientific training.

Now all the great engineering societies have recognised formally that no engineering training is complete without its academic side, and a very important committee, consisting of delegates from the five great engineering societies, with Sir William White as president, has been at work for some time, formulating their ideas as to the nature of the qualifying training, and going so far as to formulate also ideas as to the preliminary education of young engineers before they commence their academic training. I do not wish—rather I do wish very much, but it is not my subject to-day—to enter upon the very thorny questions involved in what that preliminary education ought to be according to the notions of a grown-up engineer. I will say, however, for it is no secret, that communications received from many headmasters of our great schools, while not going so far as some of us would like, are yet quite astonishingly radical in their ideas as compared not only with thirty, but even with fifteen years ago.

As to the general trend of our academic training, I think we engineers are entitled to say that it should be so arranged as best to train the best engineers. I put it in this way because I mean it to be understood that while on the one hand the *best* engineer is certainly not the man who knows his own business only and narrowly; on the other hand, I think we are entitled to demand that the engineer should not be looked upon as the mere bye-product of the training, but as the chief result to which other things are to be subordinated. I think that University College is not likely to fall into this mistake, but the point has really to be kept in mind in cases where, as here, the engineering education is only one branch of the wide range of education covered by the whole work of a university college.

In saying this, however, I particularly do *not* mean that the academic training of engineers should be laid out exactly on superficially utilitarian lines. The idea of giving a young man just as much mathematics, just as much physics, or just as much chemistry as the minimum that he can professionally require, is not only pernicious, but absolutely fallacious. I am sure that the only way of knowing a subject up to a certain point in such a fashion that, up to that point, it can be thoroughly utilised, is to study the subject up to a point very much further advanced. It is not at all a valid objection to the teaching of any particular point in mathematics or physics that it is more

1 Abridged from an Address delivered before the Union Society of University College, London, on June 29, by Dr. Alex. B. W. Kennedy, F.R.S.

2 Some talk of millimètres, and some of kilogrammes,
And some of décilitres, to measure beer and drams;
But I'm a British workman, too old to go to school;
So by pounds I'll eat, and by quarts I'll drink, and I'll work by my three-foot rule."

complicated or more advanced than anything which the engineer will be likely to require. That, in itself, is not an objection at all, because, as I have said, it is impossible really to master a scientific subject up to a certain, often very elementary, point without having at least a superficial knowledge of a much greater extent of the subject. But it is desirable, indeed necessary from our point of view, that the advanced work in purely scientific subjects should be specially chosen so as best to deepen and make certain the knowledge of the earlier work. This may be, and almost certainly is, a very different thing from choosing it so as to form the best basis for still further study of the particular science in question. In this connection I must point out—at least as my opinion—that it is a mistake to consider that there is only one mathematics or one physics, and that either the preparatory work or the whole teaching must necessarily be the same for everybody—for the man who is to devote himself to engineering, or for the man who intends to spend his life in physical work. For instance, I think an engineering student may be allowed to take for granted that A times B is equal to B times A (he is always quite prepared to believe it), and that it is perfectly reasonable to make to him dogmatic and probably in a sense erroneous, statements as to atoms (let us say) or as to the ether, without any of the qualifications which would be necessary supposing the atoms and the ether were to form the basis of the man's future studies.

It is no doubt a noble conscientiousness which sometimes prevents a man who is in the front rank among men of science from making to his students, as quite general, statements which he knows to be true only with qualifications or limitations. But the case is one in which often the general statement, given with authority, will really give the student a truer conception of the facts than a more accurate statement which is guarded by reasoning and explanations which he (that is, the student) cannot understand, and will almost certainly misunderstand. As a writer in NATURE put it a few days ago, referring to the theory of quaternions, "the truth is that very few students are able to appreciate to the full an absolutely logical argument until they have a certain amount of practical knowledge imparted to them more or less *by authority*."

There is one matter in connection with the teaching both of mathematics and physics to engineering students which I think might well be emphasised more than is generally the case. Whether it is desirable that it should be emphasised in dealing with the general student I do not venture to say. I mean the point that the answer to any question can only be as accurate as the data of that question. For the ordinary examination question in mathematical physics it is necessary and unavoidable to presuppose certain data which in real life are absurd and impossible. In the ordinary everyday questions of engineering there is nothing more misleading than to take for granted the data of the examination paper, and a very great deal of the disrepute into which mathematical work had fallen at one time among engineers was due to the fact that although the average student was able to use his methods rightly, he was unable to perceive whether they led him to a right result. I think it must be possible, even if it is not exactly easy, to point out to the student the extent to which the accuracy of his answers is influenced by the assumptions which he makes.

It is, I am afraid, too often presumed that the method of working out the answer is the chief thing; perhaps it may be from some particular point of view. But for our purposes, foolish as it may sound, the method of working out the answer is only secondary; the answer itself is the chief thing, and we really must have that answer right when it finds itself translated into steel or stone. We would much sooner have a right answer got by an imperfect method than a wrong answer got by the best method in the world. And an answer may be wrong in two ways; it may be wrong because the data are in themselves wrong, that is to say, inapplicable to the particular case, or it may be wrong by being stated in a form much more accurate than the real data will allow of, as when we find the indicated horse-power of engines given to six significant figures, when we know perfectly well that the fourth must always be doubtful.

It would be most useful if our scientific professors would discuss these points with their students and show them specially the extent to which the methods and theorems of the mathematician and the physicist may be properly applied when the only data available for the problems are such as actually are found in practice. It is hardly fair to leave the engineering professor to tell his pupils, or to leave the engineer to tell his assistants, that the methods they are using are quite inapplicable, and the results which they are getting obviously inaccurate. This is in every way inadvisable, and may lead the otherwise guileless student to discount all his teachers instead of only one. Every scientific experimenter knows that it is often the most difficult part of his work to say how alterations in data or want of knowledge of accuracy in data may affect the result, and I should like much to see this matter systematically dealt with by the teachers who have actually to do with the scientific or theoretical treatment of the questions concerned. If they have any doubt as to what is the general nature of the complex engineering questions which have to be solved, a letter addressed to any engineer in Westminster would bring them the fullest information. But happily most of the university colleges now have engineers on their Senates, so that the information can be had without going outside their own walls.

As to the more advanced part of engineering teaching in colleges, I want to put forward an idea that I have more than once had occasion to express. I should much like to see the development of some such connection between old and distinguished students of a college, who become later on older and more distinguished engineers, and the college at which they have studied or some other college, as exists in the similar case of the medical profession. My suggestion is that to get the full benefit from its best pupils, a college should, if possible, keep in touch with them after they have left it. A few years after they have left college, and when they have fairly got into the swim of professional work, but before they have so much lost touch with the difficulties of their college days that they no longer appreciate the student's point of view, they might be made to help in teaching by giving lectures on the special branches of engineering with which they were specially and actively familiar. They should do it before they have forgotten what they formerly learnt, or have had it driven out of their heads by the pressure of other ideas, and while college methods and points of view are still familiar. They would be men still making their way in their profession, still, let us hope, full of enthusiasm for their work, and certainly they would be daily finding out the differences between actual and academic problems. Teaching of this kind could in no way replace the general preliminary teaching of engineering subjects in the college, which must continue to be given, as it is given now, by a professor or professors, the bulk of whose time is spent at the college, and who are thoroughly in touch with all the students.

I confess that I hope a time will come when in any case professors of engineering will not remain permanently in academic harness, but will come out and take their place—a most important one—as colleagues among the active and leading engineers of the country, and will look upon such a position as that which they ought to reach rather than a solely academic position, however eminent. But, in addition to the work of the permanent professor or professors, I believe that old students coming back in the fashion I have indicated, not in one only, but in several branches of engineering, and giving short courses of special lectures to third year students, would very much help both the students and the rest of the teaching staff. The arrangement would also have the very great advantage of bringing about a closer and warmer connection between the men who are at work in their profession and the colleges where they were trained. It would also help to keep the colleges themselves in that actual and continual touch with engineering things and ideas which is so absolutely essential for their continued usefulness.

It will be noticed that the scheme I have outlined is closely analogous to the system already general in connection with medical training, where the lecturing and professorial staff on the technical side consists almost entirely of old students (occasionally from other colleges) who are beginning to make their way professionally, or who, by the time they have become professors, have actually made their way to the highest ranks of their profession.

HARVEY AND THE PROGRESS OF MEDICAL SCIENCE.[1]

AFTER some introductory remarks, Dr. Roberts referred to Harvey's work, and especially to his great discovery of what is commonly spoken of as the "circulation of the blood," though his published treatise is really on the "movements of the heart and of the blood." He re-affirmed their implicit belief in the absolute priority of Harvey's claim to this discovery, and spoke of its magnitude and far-reaching effects, which had been described in various and glowing terms, in no way exaggerated. Nor must they forget the formidable difficulties under which Harvey carried out his investigations; the profound errors which he had to combat and overthrow, and the confusion he had to clear away; his indomitable perseverance; and the masterly yet courteous manner in which he disputed and ultimately overcame the objections which had been raised against his views.

The orator then gave an outline of Harvey's career, dealing more especially with his association with the College of Physicians, where he held the position of Lumleian Lecturer from 1615 to 1656, in the very first course of lectures presenting a detailed exposition of his views concerning the circulation of the blood, which continued to form one of his subjects for several years. In the deed by which Harvey conveyed to the college his estate, he laid down three definite and distinct injunctions or instructions as to the subject-matter of the oration, which it was their duty to follow. The first injunction is that "there shall be a commemoration of all the benefactors of the said College by name and what in particular they have done for the benefit of the said College, with an exhortation to others to imitate these benefactors and to contribute their endeavours for the advancement of the society according to the example of those benefactors."

Dealing with this injunction, Dr. Roberts first mentioned individually Harvey himself; Thomas Linacre, the practical founder of the College of Physicians; and John Caius. He then considered generally as benefactors those who had held high office, alluding specially to that of President; those who had founded lectureships, or had given endowments for prizes, medals, or scholarships; those who had contributed to the library or to the general funds; and those who by their professional or scientific attainments and achievements, as well as by their high personal character, general culture and scholarship, and intellectual and moral qualities have shed unfading renown and lustre upon the College of Physicians.

In discussing the second injunction, namely, to "exhort the Fellows and Members of this College to search and study out the secrets of nature by way of experiment," the orator made a passing allusion in favour of vivisection, claiming for this method of investigation the cordial support of the medical faculty as a whole, with comparatively few exceptions. After referring to what the College had done as a body in advancing scientific research, he enlarged upon the great activity and promising aspects of modern research, more particularly in relation to subjects connected with the medical profession, and expressed his belief that Harvey would be amazed and fully satisfied were he to come on the scene at the present time, and realise the extent and thoroughness with which his exhortation is being carried into effect in all directions. Dr. Roberts then gave an abstract of what he had prepared for the oration with reference to the progress of knowledge and practice in connection with the circulatory system since Harvey's time, and the methods by which it had been brought about. He also directed attention to some of the more prominent examples of the beneficial results on an extensive scale of scientific and practical research, and alluded specially, as being closely connected with the circulatory system, to the "brilliant victories" which had been achieved against malaria in various parts of the world, many of them forming an integral part of this vast Empire. While paying a tribute of respect and admiration to all those who at the risk of life and health have gone forth to dangerous climates to study and fight against this and other tropical diseases, Dr. Roberts mentioned specially Dr. J. E. Dutton, the latest "martyr of science," as he had been aptly called, whose lamented death recently occurred on the Congo, where he had gone to study sleeping sickness on behalf of the Liverpool School of Tropical Medicine. He expressed on behalf of the college their deep sense of the great services which Dr. Dutton had rendered to the medical profession and to humanity, their profound regret at the premature cutting off of such a valuable life and promising career, and their heartfelt sympathy with his bereaved family and friends.

The orator concluded as follows:—The last and most agreeable duty laid upon me by Harvey's direction is to "exhort the Fellows and Members, for the honour of the profession, to continue in mutual love and affection among themselves, without which neither the dignity of the College can be maintained, nor yet particular men receive that benefit by their admission into the College which they might expect, ever remembering that *concordia res parvae crescunt, discordia magnae dilabuntur.*" With regard to the future position and reputation of this college in relation to scientific research and the progress of medicine, there can be no doubt or misgiving when we see amongst our younger fellows and members so many who are endowed with great abilities, who are full of energy, intellectual vigour, and enthusiasm in their work, and whose achievements have already brought them into conspicuous prominence and, in some cases, into the foremost ranks of our profession. May we not confidently hope that they will also ever keep in mind Harvey's last exhortation, and unflinchingly strive to maintain the high standard of character and conduct which he has placed before them? But should they at any time feel the need of an example, a stimulus, or an inspiration, let them steadily fix their attention and thoughts upon the personality, the life, and the work of our "immortal and beloved Harvey," whom it is our privilege and pride and happiness to commemorate on this anniversary.

[1] Abstract of the Harveian Oration delivered at the Royal College of Physicians on June 21 by Dr. Frederick T. Roberts.

HIGH TEMPERATURE RESEARCH ON THE FELSPARS.

AN elaborate investigation of the melting points of the felspars, devised and carried out by Messrs. Day and Allen in the physical laboratory of the United States Geological Survey, is described in a memoir just received.[1] The geological importance of laboratory research at high temperatures was strongly urged by the late Clarence King and Dr. Becker, and the well known work of Dr. Carl Barus has already furnished petrologists with a number of valuable data. The laboratory, discontinued in 1892 for want of funds, has been re-established by the exertions of Dr. Becker, and the piece of work before us has been in part subsidised by the trustees of the Carnegie Institution.

The authors describe in detail, for the benefit of other experimenters, the thermoelectric method by which they have been enabled to measure high temperatures with an error of not more than one degree. It was also found necessary to adopt some method of determining the instant of melting (where such exists) independently of the personal judgment of the operator. It appears that in

[1] "The Isomorphism and Thermal Properties of the Felspars." Part i. Thermal Study. By Arthur L. Day and E. T. Allen. Part ii. Optical Study. By J. P. Iddings. With an introduction by George F. Becker. Pp. 95; xxvi plates. (Washington, 1905.)

such minerals as the felspars the viscosity of the fused substance may be of the same order as the rigidity of the solid crystal approaching fusion, so that there is to the eye no abrupt change. The discordance between the results of different experimenters is largely attributable to this fact. The method followed was therefore to plot as a curve the relation between temperature and time, and to note the place where a change in the shape of the curve indicates an absorption of latent heat. To avoid the disturbing influence of impurities, the several felspars to be examined were prepared artificially. Thin slices of the crystallised products were studied optically by Prof. Iddings, and they are illustrated in the memoir by a series of beautiful plates.

FIG. 1.—Tabular Crystals of Bytownite from Middle of Crucible. From "The Isomorphism and Thermal Properties of the Felspars."

Anorthite was the felspar most easily crystallised, and its curve gave a sufficiently sharp melting point at 1532°. Other varieties examined had the compositions Ab_1An_5, Ab_1An_2, Ab_1An_1, Ab_2An_1, Ab_3An_1. These gave progressively lower melting points; but it was found that, in passing from anorthite towards the albite end of the series, viscosity rapidly increases and obscures the phenomenon of fusion, the break in the curve of heating becoming for Ab_3An_1 a barely perceptible deviation. For albite, and also for orthoclase, the method fails to give any result, and in a certain sense it may be said that the alkali-felspars have no melting point. In this connection, a special series of experiments gave some remarkable results. A small fragment of crystalline albite, embedded in albite glass, was heated to 1200° and slowly cooled. Thin slices showed that the crystal had melted to a glass only along cleavage and other cracks. The experiment was repeated with higher temperatures of heating up to 1250°, and it was found that, though the lanes of glass encroached more and more upon the crystal, considerable relics of the latter were still left, preserving undisturbed their original orientation. It thus appears that a mineral like albite, which melts to an ultra-viscous liquid, may be maintained for half an hour at a temperature well above its normal melting point without being completely fused. It seems doubtful whether the crystalline substance at such a temperature is to be regarded as a superheated solid or as a liquid crystal, in which deorientation is prevented by extreme viscosity.

Felspar		Melting Temperature		Specific Gravity: Crystals		Glass
Anorthite	...	1532°	...	2·765	...	2·700
Ab_1An_5	..	1500°	...	2·733	...	2·648
Ab_1An_2	...	1463°	...	2·710	...	2·591
Ab_1An_1	...	1419°	...	2·679	...	2·533
Ab_2An_1	...	1367°	...	2 660	...	2·483
Ab_3An_1	...	1340°	...	2·649	...	2·458
Albite	...	—	...	2·605	...	2·382

We reproduce in tabular form the chief numerical results obtained. The general conclusions arrived at are of great importance. The melting point curve for the lime-soda-felspars, as well as the curve of specific volume, is continuous, and not very different from a straight line, and we have almost conclusive proof that this group of minerals forms a truly isomorphous series. Further, it belongs to type i. of Bakhuis Roozeboom, the melting point falling steadily from one end of the series to the other. Here a further point of interest arises. According to theory, the crystals first formed from the fused mass should be richer in anorthite than the liquid from which they separate, and should contain an increasing proportion of albite as crystallisation proceeds. Day and Allen, however, verified in several cases that their crystals had the same composition as the mother liquid. This can only be due to undercooling, the beginning of crystallisation being deferred until the temperature had fallen below the range proper to normal crystallisation. Those natural rocks in which the felspar crystals show a zoned structure (the outer zones richer in albite) must have crystallised without undercooling, and, indeed, their felspars must have been formed within a certain range of temperature, which can be more or less closely determined. In this and other petrological applications the work of the authors affords a valuable supplement to that of Vogt.

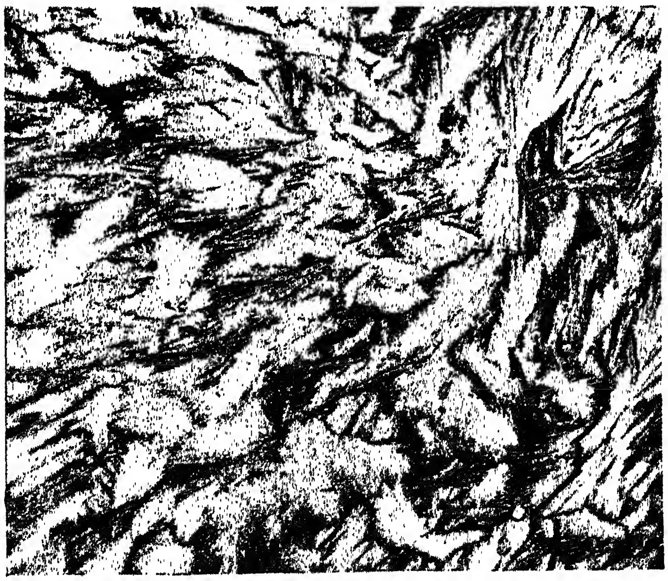


FIG. 2.—Spherulite of Plumose Bundles of Prismatic Crystals of Labradorite. From "The Isomorphism and Thermal Properties of the Felspars."

A. H.

PRIMITIVE RELIGIOUS ART.[1]

WE have on several occasions directed attention to works by American ethnologists dealing with investigations on the meanings of the designs and patterns of aboriginal decorative art. This fruitful and interesting field of inquiry is by no means exhausted, and two papers on the subject have recently been published by the American Museum of Natural History which merit the careful attention of students. Dr. Clark Wissler has made a valuable study of the decorative art of the Sioux Indians which is a model of clear and concise expression and of adequate illustration. As he truly states, the investigation becomes psychological, because it is necessary to know what ideas the artists have of their designs, and what motives lead to their execution. The assumption that all primitive decorative designs are executed with consciousness that they symbolise some definite object or relation in nature is fairly supported by the facts so far accessible, but does it follow that these symbolic designs were produced by a gradual transition from the realistic representation? That some of them were so produced has been satisfactorily demonstrated; but is this the law of growth for decorative art? It appears, among the American Indians, that the more abstract the idea, the simpler and more geometric the design. On the other hand, it is obvious that a vigorous conventionalisation of representative forms must tend to reduce them all to a few simple geometric designs. In such an event, confusion as to the symbolic aspect of similar designs must arise in the minds of the artists, necessitating re-interpretation or creation of new symbols. Thus any given interpretation need have no certain relation to the origin of the design itself; indeed, the association of the symbol and the idea can be shown in some cases to be quite secondary. Amongst the Sioux there are two main kinds of decorative art—realistic painting and conventional bead- or quill-work; the former is done by the men and the latter by the women, and there is every reason for assuming that the pictographic mode is on the whole the older. One sex has often appropriated the designs used by the other to express divergent ideas, and thus we see how even within the same tribe two or more modes of expressing symbolic motives may make simultaneous use of the same graphic designs.

In a short paper of fifty pages on the decorative art of the Huichol Indians of Mexico, Dr. C. Lumholtz has managed to crowd some 350 figures, so that we have abundant material for study. All these designs, he says, are expressions of religious ideas that pervade the entire existence of these people; in other words, they are permanent prayers. Girdles and ribbons, inasmuch as they are considered as rain serpents, are in themselves prayers for rain and for the results of rain, namely, good crops, health, and life. All the designs on pouches, shirts, skirts, and so forth express prayers for some material benefit, or for protection against evil, or adoration of some deity. Thus the magic double water-gourd, even in its most conventionalised form, means a prayer for water, the source of all life and health. Animals like the puma, jaguar, eagle, &c., express prayers for protection, as well as adoration for the deity to which the creatures belong. The little white flower, *toto*, which grows in the wet, corn-producing season, is at once a symbol and a prayer for corn, and in all sorts of forms it is to be found woven in their costumes. Flowers play, and always have played, an important part in the religion of these Indians; with them flowers, like the plumes of birds, are prayers for rain and life. Dr. Lumholtz doubts if there is such a thing as ornamentation solely for decorative purposes among the Huichol, or, for that matter, among any primitive people. Prof. Boas points out that on the whole the style of decoration of ceremonial objects differs considerably from that of the ornamental parts of garments. The former are crude and pictographic, with slight tendency to conventionalism, while the latter are regular, well executed, and strongly conventionalised, and the general character of these designs much resembles that of similar designs found in other parts of Mexico and in Central and South America. These textile designs, which are of great variety and beauty, acquire much more interest from the suggestive interpretation of their symbolism which Dr. Lumholtz has afforded us.

The American Museum of Natural History is to be congratulated on possessing collections about which so much valuable information has been obtained, and students are to be congratulated on having these riches made accessible to them by means of such beautifully illustrated memoirs.

A. C. H.

[1] "Decorative Art of the Sioux Indians." By Clark Wissler. *Bull. Am. Mus. Nat. Hist.*, vol. xviii., pp. 231–278. (New York, 1904.)
"Decorative Art of the Huichol Indians." By Carl Lumholtz. *Mem. Am. Mus. Nat. Hist.* Whole series, vol. iii. Anthropology, vol. ii. part iii. (New York, 1904.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—An examination for a geographical scholarship will be held on October 12 next. Candidates, who must have taken honours in one of the final schools of the university, should send their names to the reader in geography, Old Ashmolean Museum, by, at latest, October 2. The value of the scholarship is 60*l.*

Dr. J. Ritchie, reader in pathology, has been constituted professor of pathology so long as he holds the readership in question.

AT the recent congregation of the University of Leeds a fellowship of the value of 100*l.* was awarded to Mr. Joseph Marshall, of the Victoria University School of Chemistry.

PROF. STEPHEN M. DIXON, holder of the chair of civil engineering in the Dalhousie University, Nova Scotia, has been appointed to the new professorship of civil engineering in the University of Birmingham.

IT was mentioned by the principal of King's College, London, at the recent distribution of prizes and certificates to the successful students that Prof. W. G. Adams, F.R.S., is about to resign his chair after forty-two years' work in the college.

THE Rogers prize of 100*l.* of the University of London has this year been awarded to Dr. B. J. Collingwood for his essay on "Anæsthetics, their Physiological and Clinical Action." The essay submitted by Dr. A. G. Levy was highly commended, and an honorarium of 50*l.* was awarded him.

A MOVEMENT is now in progress for providing the North Wales University College with new buildings at an estimated cost of 175,000*l.*, of which 30,000*l.* has been already promised. The site has been given by the corporation, which has presented the deed of gift to Lord Kenyon, president of the college. The president has expressed the hope that the rest of Wales will follow the liberality shown at Bangor, and that there will be no more need for the best professors of the college to leave Bangor for more lucrative positions in other parts of the United Kingdom.

ACCORDING to the *Electrician*, a committee of the Liverpool City Council, instructed by the Finance Committee to report as to how far the educational methods employed at the Liverpool University were in the interests of the city and met its requirements, have reported that they are satisfied that the University is doing its best to ensure that its students shall enter into the business of life with their intellectual powers fully developed by providing the students with a wide range of duty and sound methods of instruction, and they have therefore recommended that the sum of 10,000*l.* should be granted during the present year upon the same conditions under which a similar grant was made for the first time last year. The report of the finance committee has come before the City Council and has been approved. Of the amount in question, 1000*l.* is devoted to scholarships for Liverpool men.

COPIES have been received of the *Johns Hopkins University Circular* containing the programme of courses for the session 1905–06, and of the Yearbook of the Armour Institute of Technology, Chicago, for 1905–06. The Johns Hopkins University will begin its thirtieth year of instruction next October. The work will be carried on

in three divisions:—The graduate department, in which arrangements are made for the instruction of advanced students in the higher branches of science and literature; the medical department, in which students (men and women) who have already received a liberal education are received as candidates for the degree of M.D., and in which doctors of medicine may attend special courses; the collegiate department, in which students receive a liberal education leading to a degree. The Armour Institute of Technology was founded in 1892, and the work of instruction was begun in September, 1893. Courses are now offered in mechanical engineering, electrical engineering, civil engineering, chemical engineering, fire protection engineering, general science, and architecture, and all lead to the degree of Bachelor of Science.

In the course of an address on degree day, July 8, at the University of Liverpool, Lord Derby, the chancellor, said that since they last met they had several new laboratories, some complete and some in progress. Another building, to be opened in November, will be for the study of natural history. They had also an extension to record of the chemical laboratories, to provide accommodation for the department of physical chemistry, and an addition to the existing department. This had been provided at an estimated cost of 10,500*l*., which the president of the council, Mr. E. K. Muspratt, had promised to contribute. Since they last met 10,000*l*. had been given by Mrs. Barrow, the borough of Birkenhead had given an annual grant of 500*l*., and a grant of 10,000*l*. had been received from the Liverpool City Council, 1000*l*. from the county of Lancaster, from Cheshire 300*l*., and from the borough of Bootle 500*l*. The sum of 1500*l*. had been given to endow a lectureship in memory of Sir William Mitchell Banks. Mr. E. Whitley had promised 1000*l*., and under the will of the late Mr. J. L. Bowes the University would receive a legacy of 8000*l*. for the benefit of the department of chemistry and other purposes. The company subsequently proceeded to the new electrotechnical laboratory, and Sir Joseph Swan formally opened the building, which he described as eminently suited for the purpose for which it was intended. The cost of the laboratory has been defrayed by a sum of 12,000*l*., drawn from the university fund, and the Lancashire County Council has contributed 1000*l*. towards meeting the more pressing demands for equipment.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 18.—"On the Chemical Mechanism of Gastric Secretion." By J. S. **Edkins**.

June 8.—"On the Application of Statistical Mechanics to the General Dynamics of Matter and Ether." By J. H. **Jeans**. Communicated by Prof. J. Larmor, Sec.R.S.

The object of the paper is to apply the methods of statistical mechanics to questions connected with radiation and the energy of the ether. An attempt is made to examine whether or not the modern theory of thermodynamics of radiation can be regarded as resting on sound dynamical principles. The result arrived at is that the use made of the second law of thermodynamics in this theory, in particular in the proof of Stefan's law, is one which cannot be justified, and hence that those parts of the theory of thermodynamics of radiation which are based upon the use of the second law must be regarded as unsound.

The problem is obtained in its simplest form by considering either a finite universe, or else a finite portion of an infinite universe, enclosed within a perfectly reflecting boundary. Let the number of degrees of freedom of the matter inside this boundary, neglecting the interaction with the ether, be N, so that there are 2N coordinates of the aggregate system which very nearly represent motion of matter only. The number N is known to be actually finite, although it may be supposed to be so large that the error involved in treating it as infinite will be negligible. Let the number of degrees of the ether be M, giving 2M coordinates to the aggregate system. If we suppose the ether to have an absolutely continuous structure, the number M will be absolutely infinite.

The energy of the 2M coordinates of the ether is expressible as a sum of 2M squares. The energy of the 2N material coordinates may, again neglecting small terms, be divided into kinetic and potential energy. The kinetic energy is expressible as a sum of N squares, namely, the sum of the three components of energy of each electron of which the matter is composed. Thus the total energy is expressible as the sum of $2M+N$ squares, plus an unknown potential energy of electrons. It now follows, as in the proof of the well known theorem of equipartition of energy, that after an infinite time the sum of any p of these squares stands to the sum of the remaining q squares in a ratio which is equal to p/q, subject only to the condition that p and q are large enough to be treated as infinite without appreciable error. Since 2M and N satisfy these conditions, it follows that the system tends towards a state in which the energy of the ether is infinite in comparison with the kinetic energy of the matter. In other words, there is a general tendency for the ether to gain energy at the expense of matter.

It is, however, obvious that our own universe is at present far removed from its final state, so that the study of this final state is of less interest than the study of the stages through which the final state is being reached.

In discussing the transition to the final state, a principle proved elsewhere ("The Dynamical Theory of Gases," chapter ix.) is of service. Suppose that a vibration of any dynamical system is influenced by an external agency. Then the principle in question asserts that the ultimate effect of this influence is infinitesimal, except when the external agency changes to a considerable extent in a time comparable with the period of the vibration. If the time of change in the external agency is n times the period of the vibration, where n is large, then the ultimate change in the energy of the vibration vanishes to the same order as e^{-n}, a quantity which soon becomes negligible as n increases.

Thus, if θ is some small interval of time, so small that the material system may be regarded as perceptibly unaltered through a time θ, then the change produced in the energy of ether vibrations of which the period is less than θ will be very slight. The energy of such vibrations may therefore be treated as though it were incapable of change, so long as our consideration of the system does not extend over a very long period.

The total number of modes of vibration of any enclosed or unenclosed piece of ether is, as has been said, either very great or infinite, but the number of vibrations of an enclosed piece of ether *of which the frequencies are below an assigned value* is finite. Thus, we can now suppose M replaced by some small number M′, and the value of M′ will be finite. So long as we limit our consideration of the system to a finite time, say a million years, we may regard the energies of the remaining modes of vibration as constant and very small. The ratio of ethereal to material kinetic energy is now $2M'/N$, a quantity which cannot be infinite and may be very small.

If θ is a small time satisfying the conditions specified, then the rate at which an ether vibration of high frequency p gains energy will involve a factor $e^{-p\theta}$, so that the time required for the vibration to acquire a perceptible amount of energy will involve a factor $e^{p\theta}$. This is, of course, only true when $p\theta$ is large. The energy of those vibrations for which $p\theta$ is not large is rapidly adjusted, and a state will soon be reached in which these vibrations have the share of energy allotted to them by the theorem of equipartition of energy. With the progress of time the energy of the remaining vibrations gradually becomes perceptible, until ultimately the final state is reached.

We cannot, however, realise in nature the boundary impervious to all forms of energy, so that it is important to consider whether these predictions have to be modified if the boundary, instead of being perfect, is simply as perfect as we can make it.

It is found that there is no longer any tendency for the energy of the matter, even after infinite time, to vanish in comparison with that of the ether inside the enclosure; the two tend to assume a finite ratio, although neither of the actual energies can be permanent, as the system

inside the enclosure is no longer a conservative system. This definite ratio between matter and ether, however, lends a meaning to the expression "radiation at a given temperature," at any rate so long as we are concerned with the same enclosure and the same enclosed matter.

Stefan's empirical law states that the radiation is proportional to the fourth power of the absolute temperature, and Bartoli and Boltzmann have attempted to raise the law to the level of a theoretical law.

Their argument rests fundamentally upon the application of Carnot's principle to the working of a heat engine, in which the working substance is the ether.

Carnot's principle is, in effect, identical with the second law of thermodynamics, and this in turn is a special case of a special proposition in statistical mechanics. In the present investigation the most general methods of statistical mechanics are used, and the conclusion arrived at is different from that of the second law. The general investigation ought, of course, to take precedence over the attempted extension of the special case. It is, moreover, easy to find the exact point at which the general argument parts company with that used in the special case. In the special case, we are dealing only with forms of material energy such that there is an easy and rapid transfer of energy to the final state. The increase of entropy indicates simply the tendency to move towards this final state, and Carnot's principle is seen to be a special case of this general tendency in which it is supposed that the working substance is at every instant in the final state appropriate to its energy at that instant. When the ether is in question, it is found that the transfer of energy to vibrations of short wave-length, instead of being infinitely rapid, is, in point of fact, extremely slow, so that we never have to deal with a final state at all.

Moreover, it has to be assumed for Bartoli's argument that the energy of the working substance is a function of only two independent variables, *e.g.* the temperature and the density. This is not true in the case of an engine in which ether is the working substance; the ether energy is the sum of a number of vibrations of different wave-lengths, and the number of vibrations which have to be included in this sum will depend on the nature as well as on the temperature of the matter with which the ether is in communication.

Again, in the proposed argument for Stefan's law, the piston of the pump forms a moving boundary for the ether. The action of such a pump would change the frequency of vibrations in the ether, and energy which at one instant belonged to a vibration of one period would, after passing through the pump, belong to a vibration of some entirely different frequency. The energy of the vibrations of high frequency no longer remains unaltered and very small, for there is a transfer of energy to these vibrations at every stroke of the pump. The system will rapidly assume the final state appropriate to the value of this total energy, and this is a state in which the energy of matter vanishes in comparison with that of ether. Thus Bartoli's proof might be applicable to a universe in which pumps of the kind assumed had an actual existence, but has no application to our own universe in which the vibrations of highest frequency do not come into play at all.

It now appears that in attempting to obtain a law of radiation in conformity with the analysis of the present paper, we shall not be able to use any method so general as that of the second law of thermodynamics. The whole question is not one of partition of energy, but of transfer of energy.

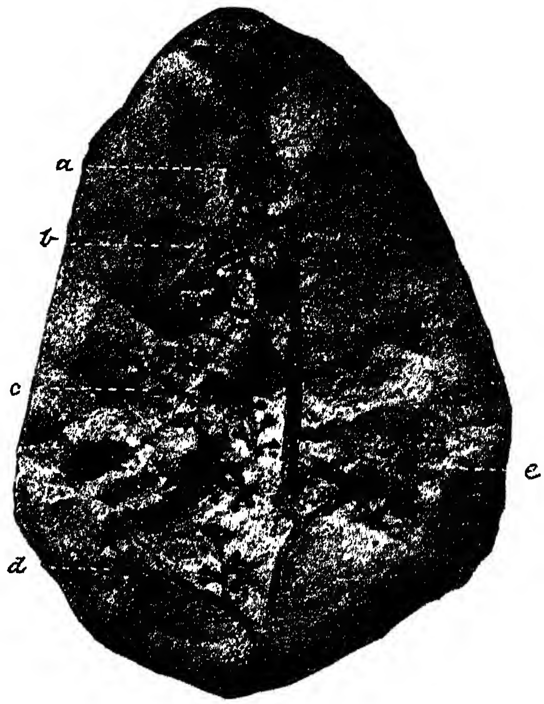
"The Microsporangia of Lyginodendron." By R. **Kidston,** F.R.S.

In a preliminary note a description was given of the microsporangia of *Sphenopteris* (*Lyginodendron*) *Höninghausi,* Brongt. It had been thought by some that the *Telangium Scotti,* Benson, might be the microsporangia of Lyginodendron, but the discovery of sporangia possessing all the characters of Crossotheca, Zeiller, in organic connection with the sterile foliage of *Lyginodendron* (*Sphenopteris Höninghausi*) shows that *Telangium Scotti* must belong to another plant.

The members of the genus Crossotheca (of which several species are known) had previously been regarded as *true ferns,* but now they must be classed with the Pteridospermeæ. The barren foliage of the species included in Crossotheca is very varied, and though the majority of the species possess sphenopteroid pinnules, one at least bears pinnules of the pecopteroid type.

In *Sphenopteris* (*Crossotheca*) *Höninghausi* each "fertile lobe bore six to eight broadly lanceolate sharply-pointed microsporangia. In the early condition the sporangia are bent inwards, and form a small hemispherical bunch with their apices meeting in the centre. At maturity the sporangia spread outwards, when they appear as a fringe hanging from the margin of the fertile pinnule, but are in reality connected for some distance to its lower surface. The microsporangia are bilocular, the parallel loculi being only separated by a narrow band of tissue. Dehiscence took place by a longitudinal cleft which passes down the inner surface of the sporangium in the line of the dividing wall of the two loculi."

The figure shows a penultimate pinna enlarged two



times. The ultimate pinnæ *c* and *d* bear sterile pinnules at their base, above which are some fertile pinnules. These latter, however, are better seen at *e*.

It has previously been shown by Prof. Oliver and Dr. Scott that the "seed" of *Sphenopteris Höninghausi* is the *Lagenostoma Lomaxi* of Williamson. *Sphenopteris Höninghausi* is thus the first pteridosperm of which the male and female organs are known.

The specimens described were derived from the 10-foot Ironstone-measures, Coseley, Dudley, which belong to the Westphalian series of the Coal-measures, and were communicated to the author by Mr. H. W. Hughes.

Royal Microscopical Society, June 21.—Mr. C. C. Karop, vice-president, in the chair.—Dr. **Lazarus-Barlow** exhibited and described a new form of warm stage, devised by him, that could be heated by oil or gas.—Mr. Cecil R. C. **Lyster** exhibited an improved form of warm stage, heated by electricity.—Mr. C. L. **Curties** exhibited an arrangement for obtaining dark ground illumination with high powers, which had been suggested to him by a contrivance made by Leitz for attaining this object. He showed *Pleurosigma angulatum* on a dark ground under a 1/12-inch oil immersion objective.—Mr. **Rheinberg** directed attention to an experiment showing that the ap-

pearance of a grating could be produced in the field of the microscope without there being anything on the stage. The lines seen were achromatic interference bands produced with the help of two of Thorp's gratings of equal pitch placed behind the objective.—Mr. **Rousselet** directed attention to a living specimen of *Plumatella punctata* (Hancock) sent by Mr. Hood, of Dundee. The rare freshwater polyzoon has apparently not been recorded in England since its discovery by Hancock in 1850. It differs from other species of Plumatella mainly in having a soft, transparent ectocyst.—A communication by Mr. E. M. **Nelson** on the tubercle bacillus was taken as read.—Mr. A. E. **Conrady** gave a *résumé* of his second paper on theories of microscopic vision. In his former paper he dealt with the formation of the image of a simple plane grating, showing that it could be fully accounted for on the basis of Abbe's theory. In the present paper he considered more complicated structures, such as dot- and cross-line patterns.

Geological Society, June 21.—Dr. J. E. Marr, F.R.S., president, in the chair.—The relations of the Eocene and Cretaceous rocks in the Esna-Aswan reach of the Nile Valley: H. J. L. **Beadnell**. At the meeting of the International Geological Congress held in Paris in 1900, the author brought forward evidence from the Baharia Oasis and Abu Roash to show that there was a marked unconformity between these two systems in the northern part of the country. The Jebel-Awaina succession shows that in the southern part of the country, where the Upper Cretaceous and the Lower Eocene occur in their fullest development, there is no sharp line of demarcation between the Cretaceous and the Tertiary, and no disturbances in the stratigraphical succession. This is confirmed by the succession in the Kharga Oasis, where there is no trace of an unconformity. Dr. J. Ball's conclusions to the contrary were mainly based on the supposed irregular variation of the Esna Shales; but, where this occurs, it is mainly due to the fact that, with a slight increase of carbonate of lime, these beds became almost indistinguishable from the overlying marls and marly limestones of the Eocene. The author finds in Jebel Nur el Ghenneiem some 180 feet of green clays between the *Echinocorys*-Chalk and the Eocene marls and limestones, and a perfectly conformable succession throughout. Near Ain Amur there is a considerable development of fossiliferous limestones at the summit of the Cretaceous rocks, and many of the fossils are hardly distinguishable from Eocene species. The author is of opinion that the Farafra succession falls into line with that which obtains in the southern part of the country. An important piece of confirmatory evidence is furnished by the discovery of a rich fauna in "ashen-grey clays" in the Esna-Aswan reach of the Nile Valley by Dr. W. F. Hume, in the clays above the *Pecten*-Marls in the neighbourhood of Esna.—A contribution to the study of the Glacial (Dwyka) Conglomerate in the Transvaal: E. T. **Mellor**. The survey of a district lying east of Pretoria and extending from near the diamond-fields to Middelburg has recently afforded much additional information with regard to the Glacial Conglomerate in this part of South Africa. The district lies on the northern edge of the principal area occupied by the Karroo system, and includes a number of outliers, the area between which affords information as to the source of the material of the Conglomerate and the character of the land-surface on which it was deposited. This surface is smoothed, grooved, and scratched by ice-action. The Karroo system is here only 400 or 500 feet thick, and the Conglomerate usually about 50 feet; but, where deposited in hollows, it may reach 200 feet or more in thickness. The fragments are usually from 1 to 3 feet in diameter, but may attain as much as 8 or 10 feet; they are often facetted and sometimes show striations. The majority of the boulders are of local origin. True bedding-planes are rare in the conglomerate, but there are included patches of sandstone, mudstone, or shale, some of which show ripple- or eddy-markings. The striæ are remarkably constant in direction, and they and the transport of boulders indicate an ice-movement from the north-north-west to the south-south-east. In the Prieska district Rogers and Schwarz found the movement to have been from north-north-east to south-south-west, and the same direction is given by Schenck from near the junction of the Orange and Vaal Rivers. During 1904 outliers of the Conglomerate were found farther north, near the junction of the Elands and Olifants Rivers.—On new Oolitic strata in Oxfordshire: E. A. **Walford**.—The causes of variegation in Keuper Marl and in other calcareous rocks: G. T. **Moody**. The author concludes that the variegation of the Keuper Marls and of other calcareous rocks has been brought about by the percolation of chalybeate water through the light-coloured mass, the more porous parts of which have in consequence become stained with ferric oxide, while the harder and more crystalline parts, being non-porous, have remained unchanged. The uniformity in distribution of ferric oxide in some red rocks, such as the New Red Sandstone, suggests that the iron contained in them has probably been derived from chalybeate water in a similar manner.

Challenger Society, June 28.—Dr. R. N. Wolfenden in the chair.—Dr. H. R. **Mill** exhibited the new chart of the world, recommended by the International Geographical Congress, and published at the cost of the Prince of Monaco. From 72° N. to 72° S. are sixteen sheets on Mercator's projection; each polar chart of four sheets is on a circular projection. The submarine contours and soundings are in metres, symbols indicating the bottom deposits. The land is black; the contours of the ocean are coloured in deepening shades of blue. Meridians (from Greenwich) and parallels are ruled for each degree.—Dr. W. T. **Calman** exhibited the two Decapoda brought from the Antarctic region by the *Discovery*, *Cranzon antarcticus* and *Chorismus antarcticus*, and explained their bearing on "bipolarity."—The **Secretary** showed a chart reproduced in line-process from one of the society's blank charts, in order to show the method of preparation.—On behalf of Messrs. E. W. L. **Holt** and W. M. **Tattersall**, Dr. Calman read a preliminary note on the Antarctic Schizopoda captured by the *Discovery*. The collection contained several new species of Euphausiidæ and Mysidæ, and the authors were able to show that *Euphausia superba* (Dana), Sars, *E. Murrayi*, Sars, *E. australis*, Hodgson, *E. glacialis*, Hodgson, and *E. antarctica*, Sars, are all referable to a single species.—The **Secretary** read a note on the probable time required by the larva of an epibenthic animal to cross the Atlantic, and made some remarks on the desirability of revising the nomenclature of ocean currents on an international basis.

PARIS.

Academy of Sciences, July 3.—M. Troost in the chair.—The theory of algebraic surfaces: **Émile Picard**.—The propagation of waves along a liquid compressible column, composed of strips of unequal velocities and filling an elastic horizontal tube, without longitudinal tension: J. **Boussinesq**.—On camphoacetic and β-camphopropionic acids: A. **Haller**. Methyl camphocarbonate heated with sodium methylate and iodoacetic ester gives methyl carboxymethylcamphoacetate, which, with alcoholic potash, furnishes camphoacetic acid. A corresponding compound is obtained by substituting ethyl β-iodopropionate for the ethyl iodoacetate in the original reaction, and from which β-camphopropionic acid is obtained.—On the existence in the black elder of a compound furnishing hydrocyanic acid: M. **Guignard**. The number of plants from which hydrocyanic acid can be obtained is increasing every year, and it has been suggested that it represents the first recognisable product of the assimilation of nitrogen in plants. In the elder, the fresh leaf furnishes the largest proportion of the acid, averaging 0·01 per cent.—Synthesis of the three tertiary dimethylcyclohexanols and of the hydrocarbons connected with them: Paul **Sabatier** and A. **Mailhe**. The cresols are converted into methylcyclohexanones by means of the reduced nickel reaction, and these are converted by methylmagnesium iodide into the corresponding tertiary alcohols, good yields being obtained. The preparation, physical properties, and reactions of the ortho-, meta-, and para-tertiary alcohols are described.—On the evolution of the tertiary mammals. A reply to the observations of M. Boule: Charles **Depéret**. A controversial note dealing more especially with the ancestry of the horse and bear.—M. P. Curie was elected a member

in the physical section in the place of the late M. A. Potier.—On the specific inductive power of metals in the case of the calorific and luminous waves: André **Broca.** The author concludes that the hypothesis of the existence of a considerable specific inductive power for the metals, although perhaps not sufficient to explain all the optical properties of metals in detail, is at least no more in contradiction with the facts than the hypothesis of Planck that this specific inductive power is zero.—An apparatus for measuring the factors, penetration, and quantity of X-rays, and a radiophotometric totaliser: G. **Contremoulins.** Silver plates of varying thicknesses are fixed on to rotating sectors, and the effect of interposing these in the path of the rays upon a phosphorescent screen is noticed.—The magneto-optical properties of ionoplastic iron: L. **Houllevigue** and H. **Passa.**—A method for establishing coloured screens, destined to isolate certain groups of special radiations: F. **Monpillard.** A given weight of a colouring matter is diluted to a certain volume with an aqueous solution of gelatin, and this poured on to a glass plate of fixed area, thus giving an invariable weight of colour per square centimetre. The author has succeeded in producing screens giving a maximum of luminosity in the green (λ 530), yellow orange (λ 588), yellow (λ 500), and red (λ 630).—The preparation of binary compounds of metals by thermochemical reactions: A. **Colani.** Some examples of the application of aluminium powder for reduction at a high temperature; the products are usually contaminated with aluminium and sometimes with iron.—The constitution and properties of the aluminium steels: Léon **Guillet.** So long as the percentage of aluminium is below 2 per cent., there is no marked change in the properties of the steel. Up to 15 per cent. the aluminium enters into solution in the iron, the iron-aluminium solution thus formed not dissolving carbon.—Combinations of ferrocyanides and sulphuric acid: Paul **Chrétien.** Hydroferrocyanic acid, dissolved in sulphuric acid without any gas being evolved, forms a sulphonic acid of the composition $H_3FeCy_6(SO_3H)$. With fuming sulphuric acid another compound is produced, $FeCy_6SO_2$, the decomposition and reactions of which have been studied.—A modification of the initial quality of iron and steel used in the manufacture of rivets consequent on the heating required in fixing: Ch. **Frémont.** It is found that the metal, after being heated and cooled under traction, is improved in quality mechanically.—On the acid γ-aldehydes: E. E. **Blaise** and A. **Courtot.** The authors have been successful in obtaining these aldedydes in a pure state for the first time. An unsaturated acid is treated with bromine, the dibromo-acid formed heated, a bromo-lactone being then formed by the loss of hydrobromic acid. Hydrobromic acid is then removed from this by boiling with quinoline, and the lactone thus produced, hydrolysed with an alkali, gives the acid aldehyde required.—The synthesis of the lactone of erythric acid: M. **Lespieau.**—A new method of synthesis of the monoatomic and polyatomic alcohols: V. **Grignard.** This important synthesis has been achieved by the author by acting with organometallic derivatives of the type RMgX on the halogen derivatives of the mono- or poly-atomic alcohols. The reaction takes place in two stages,

$$RMgX + ClCH_2.CH_2.OH = RH + ClCH_2.CH_2.OMgX,$$

and this on heating gives with a fresh molecule of a magnesium compound

$$R'MgX' + ClCH_2.CH_2OMgX = MgX'Cl + R'.CH_2.CH_2.OMgX.$$

The action of water on this last substance gives the alcohol $R.CH_2.CH_2.OH$. Several examples of the application of this synthetical method are given.—On β-decahydronaphthylketone and β-decahydronaphthylamine: Henri **Leroux.**—Some new derivatives of the mesoxalic esters: Ch. **Schmitt.**—The action of ethyl iodide on sparteine: Charles **Moureu** and Amand **Valeur.** The reaction gives sparteine iodohydrate and two isomeric iodoethylates.—The densities of carbonic anhydride, ammonia, and nitrous oxide: Philippe A. **Guye** and Alexandre **Pintza.** The results for the densities of nitrous oxide and carbon dioxide agree with those of Lord Rayleigh within the limits of experimental error, 1/6000 to 1/19,000. Special precautions were taken in the case of ammonia to ensure the absence of amines, the result being 1/700 lower than the figure of M. Leduc. The limiting densities for these gases were worked out, and the atomic weight of nitrogen deduced as 14·006.—The thermochemistry of neodymium: Camille **Matignon.**—The influence of the elements of brown flour on the extraction of the gluten and bread-making: M. **Lindet** and L. **Ammann.**—On the cause of the withering of the vines in Tunis, Algeria, and the Midi: L. **Ravaz.**—On the presence of a hydrocyanic glucoside in the leaves of the elder, *Sambucus nigra*: Em. **Bourquelot** and Em. **Danjou.** The elder leaf contains a glucoside containing nitrogen, which, under the influence of emulsin, gives glucose, hydrocyanic acid, and an aldehyde.—Modifications and *rôle* of the segmentary organs in some annelids: Louis **Fage.**—On the epipodites of the Eucyphote Crustacea: H. **Coutière.** On the discovery of coal at Abaucourt (Meurthe-et-Moselle): René **Nicklès.** A layer of coal, 2·65 metres thick, has been found at Abaucourt, near Nomeny. It is at a depth of 896 metres, and on chemical analysis proves to resemble the gas coal of Saarbrück.—Observations on the preceding note: R. **Zeiller.**—On the geology of the Pre-alps in the neighbourhood of Jaen: Robert **Douvillé.**—Contribution to the tectonic of the southern Carpathians: G. M. **Murgoci.**—On the origin of lactose. The ablation of the mammæ in lactation: Ch. **Porcher.**—The fixation of chemical substances on living cells: MM. **Charrin** and **Le Play.**

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THURSDAY, JULY 20, 1905.

ARCTIC METEOROLOGICAL OBSERVATIONS.

The Norwegian North Polar Expedition, 1893–1896; Scientific Results. Edited by Fridtjof Nansen. Vol. vi. Published by the Fridtjof Nansen Fund for the Advancement of Science. Pp. xiv+659; 20 plates. (London: Longmans, Green and Co., 1905.) Price 36*s*. net.

IT is a misfortune that meteorological results demand so many figures for their discussion, and so much space for their exhibition. Vol. vi. of the Norwegian North Polar Expedition, dealing with the climatology of the area through which the *Fram* drifted in its memorable voyage, 1893–6, is a most interesting book, but its size and appearance might repel any but the most ardent meteorologist. The discussion of the observations has been undertaken by Prof. Mohn, of Christiania, and the arrangement is a model of clearness and efficiency. Prof. Mohn superintended the whole meteorological equipment, suggested the plan of work to be carried out during the voyage, and arranged with Captain Scott-Hansen the general management of the meteorological work. We imagine Prof. Mohn must be gratified with the success of his arrangements, and the intelligent interest which the officers of the expedition have shown in the work. Notwithstanding the severity of the climate, there is hardly a gap in the series of observations. At sea, the observations were taken at intervals of four hours, but for the greater part of the time the readings were made every two hours, with a regularity that compels admiration. The result is that we have, with very considerable accuracy, the climatological elements of a region in the circumpolar Arctic Ocean, where the surface of the earth during the whole time was of a unique homogeneous nature, consisting of a level of frozen water, remote from continents and islands, and with an uninterrupted free horizon.

The wind, particularly with regard to direction and velocity, is the first element discussed. To obtain a sufficiently long series of observations for investigation, Prof. Mohn divides the interval into three groups, a dark season when the sun was below the horizon, a sunny season during which the sun was above the horizon for practically twenty-four hours, and the equinoctial months, during which there was regular day and night. The discussion shows that during the *dark* season the wind shifts generally against the sun. Only during four hours in the twenty-four does the wind veer with the sun, while in the *sunny* period the wind veers with the sun, backing about six hours, divided into periods of two hours each at three different periods of the day. In the equinoctial months the backing and veering are equal, the wind shifting with the sun during the night and morning, and against the sun from 10 a.m. to 10 p.m. The diurnal period of the wind's direction is a phenomenon which still awaits an explanation, and the different direction of the shift of the wind in the dark and in the sunny season seems to be of some importance for the solution of the problem. With reference to the velocity of the wind, it is shown to be greater when the sky is overcast than when it is clear. In the former case, the average velocity is 5.09 metres per second (11.4 miles per hour), and in clear weather only 3.54 metres per second (8 miles per hour). The greatest velocity recorded appears to be 40 miles an hour in February, 1896.

The discussions of the variations of temperature are very interesting, but the results drawn from them regarding the periods of the meteorological elements must of necessity be less trustworthy than if there had been a longer series of observations at disposal. It may therefore be premature to draw conclusions as to the connection between the different observed phenomena, and between those phenomena and their probable causes. The desirability of a longer period, and the character of the errors that can be introduced by the comparison of but few values, are shown very readily if we attempt to derive the month of lowest temperature from the figures given. The readings are centigrade, and show the mean temperature for each month:—

	January	February	March	April
1894	−35°.72	−35°.57	−37°.08	−21°.31
1895	−33.71	−37.18	−35.01	−28.89
1896	−37.33	−34.73	−18.89	−18.15
Mean	−35.59	−35.83	−30.33	−22.78

The great variation of temperature in March, 1896, making it nearly equal to that of April, demonstrates the uncertainty that must accompany any attempt to derive mean values from short periods. But the deductions drawn directly from the observations, and supported as they are in many instances by similar observations made in Arctic latitudes, are not liable to the same uncertainty. Among these results may be placed the following:—Throughout the dark winter months, when the sky is clear, the lowest temperature occurs in the *day*, the highest during the night. Generally, in the other months, we have the ordinary diurnal period. With the sky overcast, the diurnal period, with a minimum in the early morning hours and maximum after noon, is very well developed in all the months except January.

"The most striking feature," says Prof. Mohn, "seems to me to be the distinct diurnal period of the ordinary march in the winter and dark season, with the sky overcast and relatively higher temperatures. The inverted period with clear sky in the dark season seems to be due to the diurnal period of the wind's direction. The dark-season period with its stronger, south-easterly winds, is hardly to be accounted for by the radiation from the sun or sky."

The forms of cloud, the relative humidity, and the amount and character of precipitation are discussed at full length, but do not present results of unusual importance. With regard to the latter, however, it is not altogether uninteresting to notice that the number of days in a year on which rain is probable is 49, while snow may be expected on 157 days, and some form of moisture will be collected on 180 days.

Hail fell on only 5 days throughout the whole period. Rain can fall only from May to October, and July has the greatest number of rainy days, also it is the month which gives rise to the greatest amount of fog. Very considerable care was taken to determine the temperature of the Polar ice, but, naturally, much difficulty was experienced in recovering the thermometers from the bore-holes, in which they might be frozen fast, while during the summer, the viscous ice would close round them, requiring the thermometers to be dug out. Neither is it easy to remove the sources of error from the observations, especially from the effects of brine contained in the ice, which was apt to fill the bottom of the holes even during the coldest season, whilst during the summer all the holes were filled with briny or saline water, the salinity of which decreased inversely as the temperature. This brine percolated from a different level to that in which the thermometer was placed. In the winter time the temperature of the ice increased from the surface downward, and therefore the brine at the bottom of the hole was probably of too low a temperature. On the other hand, in the summer time, the ice near the surface was warmer than that lower down, and the brine would be less saline, and consequently lighter in the upper layers than in the deeper, so that in the summer time the temperature reading would again be too low. The result drawn from the observations is that the surface of the ice, in all months with the single exception of June, is warmer than the air. The difference is greatest in December, amounting to 16° F. The surface of the ice, being covered, except during a short time in summer, with snow, is protected from cooling by radiation upwards, and receives heat from the underlying warmer layers. This, no doubt, is the main factor in the explanation, though other causes are suggested by Prof. Mohn.

The book contains also an account of the meteorological observations made during the sledge expedition to Franz Josef Land in 1895–6. From this account we can quote only one remark, which illustrates the determination of the leader of the expedition to secure an unbroken series of observations.

"We had no lantern for the reading of the thermometer, and I tried in vain to construct one, which would not burn more oil than we could afford to use. But our eyes of course became gradually trained to see in the dark, and even in mid-winter, with no moonlight, there was so much light reflected from the snow that the column of the darkly coloured Metaxylol was dimly visible, and also the figures of the thermometer scale, but not the division marks."

Dr. Nansen therefore apologises for the absence of the decimal reading, which is missing about the time of new moon. The interest of the book is necessarily largely centred in the fact that the crew of the *Fram* laboured so diligently and so well to overcome the difficulties that were imposed upon them by the situation in which they were placed. To go up to the crow's nest to take additional readings of the instruments in dark, wintry weather seems to have been a source of positive enjoyment to those who took part in these observations.

EUROPEAN AND ASIATIC GEESE.

The Geese of Europe and Asia. By Sergius Alpheraky. Pp. viii+198; 24 plates. (London: Rowland Ward, Ltd., 1905.) Price 3*l*. 3*s*. net.

AT the present day most works on ornithology of a general character are of little permanent value because the broad outlines of the northern fauna have already been adequately dealt with. What we want, and what we so seldom see, are complete life-histories of separate groups of birds, adequately illustrated and described by ornithologists who are both well acquainted with them in the field and are capable of summarising their labours in an accurate scientific account. To do this a very large series of birds must be collected, examined and digested, and this means years of travelling and study with little monetary reward as the result. Nevertheless, the works of such men are of great and permanent value, although their costly nature must ever be a constant drawback to the producer. No good form of colour printing is cheap, and as this is a *sine qua non* in works of this kind, the results can only pass into the hands of a public "fit but few."

The latest of these monographs is that of "The Geese of Europe and Asia," by Mr. S. Alpheraky, and the Russian naturalist is to be congratulated in giving us the first detailed account of this interesting and, we may say literally, confusing group of birds. It is an admirable treatise, full of research in field and museum, and the work of one who has carefully studied the subject from all points of view. There are twenty-four coloured plates by Mr. F. W. Frohawk, which are unfortunately only moderately successful. Twenty-one of these represent the different kinds of geese described by the author, and for the most part the lithography is weak and hard, and evidently does not do justice to the artist's careful work; whilst the three plates representing the bills of four various kinds are excellent, and will be of the greatest use both to sportsmen and naturalists in the determination of species. The frontispiece to the work represents the assemblage of white-fronted and red-breasted geese on a sandspit, and is from the brush of Dr. Sushkin. The idea of movement exhibiting the various attitudes into which these birds throw themselves is very fairly represented, but the technical work of painting and the drawing of some of the wings, as well as the general composition, leave much to be desired. It seems a thousand pities that chromolithography is a dying art, and that no firm in Europe is capable of turning out first-class work except W. Greve, of Berlin. For all we know, these drawings by Dr. Sushkin and Mr. Frohawk may have been soft and truthful representations of nature, but here we only see hard and black lines such as nature never shows.

Mr. Alpheraky is evidently a keen sportsman as well as a good naturalist, and he rightly holds a high view of the remarkable intelligence of this class of birds.

"Geese," he says, "afford one of the most difficult kinds of fowling. However cunning man may be, he

finds it extremely difficult to over-reach these wary birds, and in some places one may see them in hundreds of thousands for several weeks at a stretch without the possibility of securing a single specimen. This is especially the case in thickly populated regions, where the geese already know that danger may threaten them."

By this we know that the writer has toiled and suffered many disappointments. In certain British waters where for three seasons Brent geese were abundant we never obtained more than one good shot with the punt gun in a season. This was generally at the commencement, when the birds arrived in late October. After this date we could only "look" and "long." Other species are equally cunning.

The key to genera, species, and subspecies with which the author furnishes us is an excellent compilation, although he does not make clear the difference between species and subspecies. For instance, it appears that full specific rank is accorded to *Branta bernicla, Branta bernicla glaucogaster,* and *Branta bernicla nigricans,* the three varieties of the Brent goose which visit our shores. If those which are furnished with trinomial names are intended to be subspecies, and it is a very doubtful point if they deserve even this distinction, the author should say so in his table. Personally we do not think that there is any reason for separating these three well marked varieties. We have killed all three from one flock, and visitors to the northern breeding-places of these birds have also found all three, as well as intermediate forms, breeding together on the same ground. If such splitting were to come into general use, endless new subspecies must be created amongst the goldfinches, crows, skuas, &c., and many other birds we could mention the slight local peculiarities of which afford small points of distinction. Neither is the author consistent in this respect, for he refuses to recognise "two geographical races, much less two species," of grey geese living in eastern and western areas, and also the American and European forms of the white-fronted goose as distinct. With regard to the bean goose, Mr. Alpheraky recognises three distinct races, *A. segetum,* the common bean goose, *A. arvensis,* which possesses white feathers at the base of the bill, and the eastern bean goose, *A. serrirostris,* a bird described by Swinhoe, which is larger, distinguished by its more massive bill. Another species closely allied to the last named, namely, *A. mentalis,* but which was first described by Przewalski in 1876, seems to be of very doubtful rank, and may be only a large form of the Siberian bean goose.

In this excellent monograph the author gives us all we wish to know about the difference of sexes, gradual growth from nestling upwards, plumage variation, moulting, local names, chase, and colour of the soft parts, the latter, perhaps, the most important point of all in the determination of species. Many excellent outline figures of the bills are also given, so that the reader has no difficulty in recognising the differences of the various races even if he feels inclined, as he must sometimes do, to question the necessity of specific separation.

To the oologist, too, the table and descriptions to be found on pp. 185–190, furnished by Mr. G. F. Göbel, are of the most exact and comprehensive nature, and the book is one that every working naturalist or wildfowler should possess in his library, for it is by far the best work that has as yet appeared on this interesting family of birds. J. G. M.

THE ELECTRIC FURNACE.

Le Four Électrique: son Origine, ses Transformations et ses Applications. By Adolphe Minet. 1er Fascicule. Pp. 76. (Paris: Librairie Scientifique, A. Hermann, 1905.) Price 5 francs.

THE application of electric heating to various metallurgical and other industries has of late been making very rapid progress. The time seems, therefore, to be well chosen for examining the various stages of development which the electric furnace has passed through.

M. Minet has taken great pains to collect together as much as possible of the available information, and has certainly succeeded in producing an interesting study. Chronologically, he divides his subject into three periods:—(1) laboratory furnaces (1808–1886); (2) industrial furnaces (1886–1890); (3) development of the industrial applications of the electric furnace from 1890 to the present day. The furnaces themselves are classified in nine groups, according to the function of the current and the method of its application. Any historical treatment of such a subject as this, which expects to be generally recognised as authoritative, demands very great care and judgment in its preparation. The present review certainly promises to be the most complete which the electric furnace has yet received.

It is, however, not so clear that the author has succeeded in accentuating just those developments which have been of the greatest influence to the general progress. There are no doubt difficulties in deciding between two such different claims as those of a brilliant invention and of a painstaking scientific investigation. The successful historian must, however, accurately estimate the value of each and decide on the relative merit according to the influence exerted by each upon subsequent development.

The classification of electric furnace processes is complicated, not only by the large number of separate cases which have to be considered, but more especially by the very different purposes for which the electric current is applied. In the first place it is necessary to distinguish between the purely electrothermal and the electrolytic functions of the current. The latter case embraces all such electrolytic methods as are carried out at a moderately high temperature. Here the electric current serves the double function of maintaining the necessary temperature and separating by electrolytic decomposition one or more of the constituents of the materials treated in the furnace.

During recent years the most extensive developments in electric furnace work have centred around the production and application of extremely high temperatures. The direct results of the scientific and

industrial discoveries along these lines have been very far-reaching. The success attending the investigation of various chemical reactions occurring at high temperatures has caused a marked revival in the interest taken in inorganic chemical research. This has been especially noticeable on the Continent, where, to a much greater extent than with us, the brilliant and rapid development of organic chemistry had led to a marked neglect of this older branch of the science.

The technical results are hardly less important. Several new and flourishing industries have been firmly established, some of them supplying hitherto unknown materials, which are proving themselves of great value in the arts. A still wider field of usefulness for the electric methods of heating seems now to be opening up. So far as the electrolytic and high temperature applications are concerned, there has been no direct competition with any existing technical processes. But now that the engineer and chemist have become familiar with the use of the electric furnace, there is a great tendency to extend its employment to work which requires temperatures already attainable by fuel heating if properly applied.

The possibility of generating the heat just where it is required, the ease of regulation of temperature, and the accompanying economy of heat losses, are the chief factors which tell in favour of electric heating under these conditions. The production of carbon bisulphide and the rapid development of the electrical manufacture of steel form excellent examples of what is being achieved technically in this direction; whilst even in the laboratory electrically heated tube and muffle furnaces are being largely employed in place of those heated by gas.

It is with the interesting details of such subjects as these that M. Minet is concerned. In view of the fact that this is but the first part of his complete work, it is impossible to do more than point out these main divisions of the subject. The author has drawn largely on the patent literature, and has copiously illustrated his descriptions with excellent diagrams and with the portraits of many of the leading investigators in this field of work. R. S. HUTTON.

OUR BOOK SHELF.

Elementary Microscopy. By F. Shillington Scales, F.R.M.S. Pp. xii + 179. (London: Baillière, Tindall and Cox, 1905.) Price 3s. net.

No instrument of research has such wide application in various branches of science and commerce as the microscope. It is, perhaps, scarcely too much to say that the principles underlying its construction and use are often disregarded by those who employ it, and sometimes totally ignored. Any treatise, therefore, on this subject, however unpretentious, is to be cordially welcomed, and the book now under notice is one that should meet a pressing need. It is written for beginners or for those who have used a microscope without troubling to understand it, and who consequently have never by any chance used it at its best.

The book commences with a description of various simple magnifiers and a descriptive diagram showing the essential parts of a microscope. These parts and the various accessories are in turn described more fully, as well as such appliances as are usually only found in the best instruments.

The most important points, such as substage condensers and fine adjustment construction, are treated somewhat fully. As to the choice of a microscope, reference is made to the fact that in medical schools and elementary science laboratories, where the cheaper form of instrument is usually provided, still no instruction is given as to its use, and that it is too often looked on as a mere magnifying glass. This is unquestionably true, and it is much to be deprecated that, in cases where the microscope performs such an important part in the work of instruction, no attention whatever is bestowed on its principles and use. The most interesting paragraphs in the book are, perhaps, those in which a comparison is made between the English and Continental stand. That the form of instrument now known as the English model is generally much superior in design and construction to the Continental stands is admitted and insisted on by the majority of those whose opinion is of value. At no period for many years past has the English microscope stand held such a high place, and it is greatly to be hoped that those who are in a position which gives them opportunities of recommending one form or another will recognise this. It is much to be regretted that, so far as objectives are concerned, the same cannot be said. Some English makers do undoubtedly produce lenses of good quality, but the average is not so high, and the finest objectives produced by Messrs. Zeiss are still unexcelled by those of any other makers. In the production of substage optical appliances, this country holds, as it has always done, a very high position, and it is difficult to understand why the same cannot be said of objectives. All the usual microscope accessories, as well as their method of use, are described as fully as the circumstances permit.

Chapters vi. and vii. are devoted to the practical optics of the microscope and its manipulation. This is the most important section of the book, and should be carefully studied. Perhaps more space might have been devoted to this, although it is quite easy to understand the difficulties that might arise in attempting anything like an exhaustive treatise on microscopic optics, debatable as the subject still is.

Altogether, the book is to be commended as a genuine attempt to treat the subject in a simpl straightforward manner, so that the reader for whom it is primarily intended may grasp its meaning without difficulty. J. E. B.

The Practical Photographer's Annual, 1905. Edited by Rev. F. C. Lambert. Pp. xxxvi + 160. (London: Hodder and Stoughton, 1905.) Price 1s. 6d. net.

THESE pages, as we are told in the preface, are intended to serve no other purpose than to aid the memory of the busy photographer, and if possible to anticipate his daily needs.

An examination of the book shows that the editor has very successfully accomplished his task, and at the same time has not made the volume of such a bulky nature as to render its size inconvenient. It is true that more references might have been inserted, but such an addition would perhaps be questionable.

The four sections into which the book is divided include a dictionary of practical hints, dodges, &c.; a collection of tables, weights, measures, everyday formulæ, &c.; a directory of the photographic societies of Great Britain and Ireland; and finally, a set of indices to the first twelve numbers of the present (library) series of the *Practical Photographer.* Each

of these sections is arranged so far as possible alphabetically, so that ready reference is greatly facilitated. We thus have a concise and practical dictionary which should be found of very general utility.

Murray's Handbook of Travel-Talk. Nineteenth edition. Pp. 688. (London: Edward Stanford, 1905.) Price 3*s.* 6*d.*

THAT this little pocket-book meets the requirements of travellers is shown by the fact that this is the nineteenth edition that has been issued. The success of such a companion depends mainly on the arrangement and scope of the material which it contains, and on these points it seems difficult to suggest any improvements. This edition is divided into fourteen distinct but comprehensive groups of subjects, each one containing exclusively those words and phrases which naturally belong to each section. Great pains seem to have been taken to bring the information up to date, motoring, for example, having quite a large part devoted to it. The Britisher is equally helped in either French, German, or Italian, and such a *vade mecum* as is here presented should be found of great service to everyone who crosses the Channel.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Pressure of Radiation on a Clear Glass Vane.

IN NATURE, June 29, a letter from Mr. G. F. Hull appeared under the above title. In it the writer claims to have verified experimentally that the pressure upon a transparent vane is equal to the difference in the density of energy in front of and behind the vane, and reference is made to a difference of views regarding the theory of the pressure in a non-absorbing medium.

In regard to the latter point, the same result is obtained for the particular case in question whether the beam of light is considered simply as a carrier of momentum or whether the pressure due to radiation is regarded as arising from a mechanical bodily force integrated throughout the material medium in which the radiation is being propagated. Consider the latter theory for steady radiation consisting of plane polarised waves of simple harmonic period $2\pi/\kappa c$ propagated along Ox (see Larmor, *Phil. Mag.*, vol. vii., p. 578, 1904).

We have

$$\frac{\epsilon}{c}\frac{\partial Y}{\partial t}=-\frac{\partial \gamma}{\partial x};\quad -\frac{1}{c}\frac{\partial \gamma}{\partial t}=\frac{\partial Y}{\partial x};$$

where ϵ is complex if the medium is absorbing.

The mechanical force per unit volume is directed along Ox and is given by

$$F=\frac{1}{c}\gamma\,.\,(\text{true current})=-\frac{\partial}{\partial x}\left[\frac{\gamma^2}{8\pi}+\frac{1}{8\pi\kappa^2c^2}\left(\frac{\partial Y}{\partial t}\right)^2\right].$$

If all the interfaces are perpendicular to Ox, then γ and Y are continuous throughout, whether the medium vary continuously or abruptly; consequently the mean value of the mechanical force upon any slice of the medium can be expressed as a pressure per unit area upon each surface equal in amount to the mean value of $(\gamma^2+Y^2)/8\pi$ at the surface. Thus for any vane suspended in free æther (or air) the resultant mechanical force is equivalent to a pressure per unit area equal to the difference in energy-density in front of and behind the vane.

The apparent confusion arises from the usual statement that the mean value of γ^2+Y^2 can only vary along Ox in the case of an absorbing medium, but this is true only for progressive waves. For a transparent medium of refractive index n conveying progressive and regressive waves the mean value of $(\gamma^2+n^2Y^2)/8\pi$, or the mean value of the energy density, is constant; but the mean value of $(\gamma^2+Y^2)/8\pi$ varies harmonically along the direction of propagation. For a plate extending from $x=0$ to $x=h$, and subjected to a normally incident beam of mean energy-density I, it can easily be verified that the mean value of $(\gamma^2+Y^2)/8\pi$ within the plate is equal to

$$I\{(n^2+1)^2-(n^2-1)^2\cos 2n\kappa(h-x)\}/\{(n^2+1)^2\sin^2 n\kappa h+4n^2\cos^2 n\kappa h\};$$

consequently the resultant pressure is equal to

$$2I(n^2-1)^2\sin^2 n\kappa h/\{(n^2+1)^2\sin^2 n\kappa h+4n^2\cos^2 n\kappa h\},$$

or equal to $2J_0I$, where J_0 is the normal reflecting power of the plate for the radiation used.

T. H. HAVELOCK.

St. John's College, Cambridge, July 14.

An Omitted Safeguard.

IN two schemes set out in a recent issue of NATURE, one dealing with the requirements of Oxford and one with the organisation of applied science in London, there appears a noteworthy omission.

If the weather is proverbially the first topic of conversation of Englishmen, it is surely because of the influence it has on the well-being of the community.

Yet in both the schedules referred to no provision is made for research in meteorology. It is singular how tardy is the recognition of so important a factor in the national welfare. It is to meteorology that we constantly appeal for help. By its daily survey of rainfall it safeguards our water supply (now a very anxious problem, being outpaced by the ever-increasing demands of population, sanitation, railways, or manufacturing machinery). We turn to it for the comparison of localities and to study the effects of climate or fog upon health and disease, or to ascertain the relations of temperature, sunshine, or rainfall to the prosperity of the crops and fruit gardens. We look to the readings of the barometer to protect the safety of those working underground. Meteorology takes cognisance of the force of the wind for the protection of structures, or of storms likely to imperil the mariner on his voyage, and by the extension of, and the improved modes of, forecasting the weather is becoming each year of greater service to all.

Without encroaching further upon the limits of your space, sufficient has perhaps been said to show *primâ facie* grounds (while so much is proposed to be devoted to physics, geology, or botany) for the consideration of a possible chair in meteorology, or for in some other way repairing an omission of so serious a kind in the schemes lately propounded. The large amount devoted annually to meteorology in the United States shows the appreciation of its utility to all classes of the community by so practical a people as the Americans, and that the outlay is amply recouped by the value of the services rendered by it.

RICHARD BENTLEY.

The Hydrometer as a Seismometer.

IN NATURE of June 29 Mr. Bennett discusses the motion of a floating hydrometer when vertical motion is imparted to the (rigid) vessel containing the (incompressible) fluid in which the hydrometer floats. The solution offered is that the whole system moves precisely as a rigid body would move, and this solution clearly satisfies the very simple equations of motion in the problem considered. But is such motion stable? In general it is not, and I believe that Faraday studied experimentally the "crispations" of a free surface of liquid when small vertical oscillations were imparted to the containing vessel.

This hardly affects Mr. Bennett's conclusion that a floating hydrometer is an unsatisfactory form of seismometer, but perhaps it may explain the positive results which some observers have obtained; elastic yielding of vessel or hydrometer, although conceivably an adequate explanation, is not the only one open to us.

Cambridge. C. V. BURTON.

NOTES ON STONEHENGE.[1]

VIII.—On the Dartmoor Avenues (*Continued*).

MY inquiries began at Merrivale because there is a circle associated with the avenues a little to the south of the west end of the longest; and again nearly, or quite, south of this there is a fine menhir, possibly used to give a north-south line. There is another menhir given on the Ordnance map, azimuth N. 70° 30′ E., which, with hills 3° high, points out roughly the place of sunrise from the circle in May (April 29). Although this stone has been squared and initialed, I think I am justified in claiming it as an ancient monument. There is still another, azimuth N. 83° E., giving a line from the circle almost parallel to the avenue. I hope some local achæologist will examine it, for if ancient it will tell us whether the N. avenue or the circle was built first, a point of which it is difficult to overrate the importance, as it will show the strict relationship between the astronomy of the avenues and that of the circle, and we can now, I think, deal with the astronomical use of circles after the results obtained at Stonehenge, Stenness and the Hurlers as an accepted fact. With the above approximate values the date comes out 1750 B.C., the declination of the Pleiades being N. 6° 35′.

I now pass on from Merrivale as an example of those avenues the direction of which lies somewhere in the E.-W. direction. Others which I have not seen, given by Rowe, are at Assacombe, Drizzlecombe and Trowlesworthy; to these Mr. Worth adds Harter or Har Tor (or Black Tor).

The avenues which lie nearly N. and S. are more numerous. Rowe gives the following:—Fernworthy, Challacombe, Trowlesworthy, Stalldon Moor, Batterdon, Hook Lake, and Tristis Rock. Of these I have visited the first two, as well as one on Shovel Down not named by Rowe, and the next two I have studied on the 6-inch Ordnance map.

Fernworthy (lat. 50° 38′).—Here are two avenues, one with azimuth N. 15° 45′ E., hills 1° 15′. There is a sighting stone at the N. end. We appear to be dealing with Arcturus 1610 B.C. This is about the date of the erection of the N. avenue at Merrivale.

The second avenue has its sighting stone built into a wall at the south end. Looking south along the avenue, the conditions are azimuth S. 8° 42′ W., hills 3° 30′.

Both these avenues are aligned on points within, but *not* at the centre of, the circle.

Challacombe (lat. 50° 36′).—This is a case of a triple avenue, probably the remains of eight rows, in a depression between two hills, Challacombe Down and Warrington. There is no circle. The azimuth is 23° 37′ N.W. or S.E., according to direction. The northern end has been destroyed by an old stream work; there is no blocking stone to the south on either of the remaining avenues, but one large menhir terminates one row of stones. The others may have been removed. So it is probable that the alignment was to the north. If so, we are dealing with the setting of Arcturus, warning the summer solstice sunrise in 1860 B.C. To the S. the hills are 4° 48′, to the N. 4° 50′.

To this result some importance must be attached, first, because it brings us into presence of the cult of the solstitial year, secondly, because it shows us that the system most in vogue in Brittany was introduced in relation to that year. In Brittany, as I have before shown, the complicated alignments, there are 11 parallel rows at Le Ménac (p. 99) (there *were* 8 parallel rows at Challacombe), were set up to watch the May and August sunrises, and the solstitial alignments came afterwards. The Brittany May alignments, therefore, were probably used long before 1860 B.C., the date we have found for Challacombe, where not the sun rise, but the setting star which gave warning of it was observed.

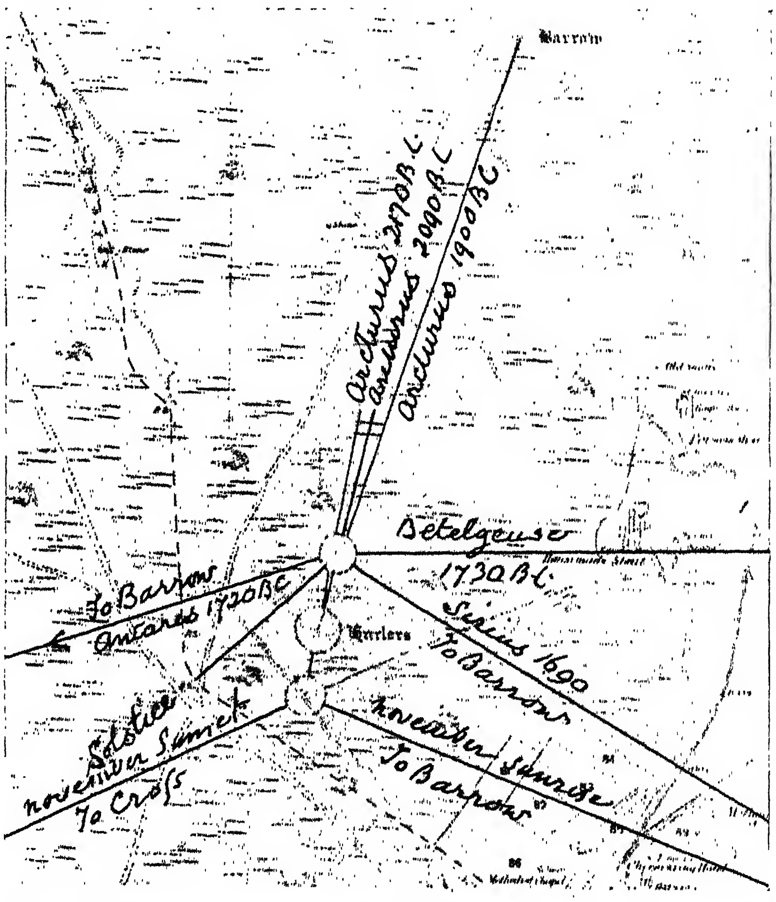


FIG. 20.—The sight-lines at the Hurlers, showing high northern azimuths among others. From the Ordnance map.

It is worth while to point out that at Challacombe, as elsewhere, the priest-astronomers so located their monuments that the nearly circumpolar stars which were so useful to them should rise over an horizon of some angular height. In this way the direction-lines would be useful for a longer period of time, for near the north point the change of azimuth with change in the declination of the star observed is very rapid.

Shovel Down, near Batworthy (lat. 50° 39′ 20″).—

[1] Continued from p. 248.

A group of five rows of stones, four double, one single, with two sets of azimuths.

One set gives us 22°, 25°, and 28°. They seem to be associated. I will call them A, B, and C. A is directed to the circle on Godleigh Common. Its ends are free. B is a single line of stones to the E. of the triple circle, about which more presently. It is not marked on the Ordnance map; its ends are also free. C has its south end blocked, I think in later times, by a kistvaen. The astronomical direction may be, therefore, either N.W. or S.E. We find, however, a probable use in the N.W. quadrant, as at Challacombe, Arcturus setting at daybreak as a warner of the summer solstice.

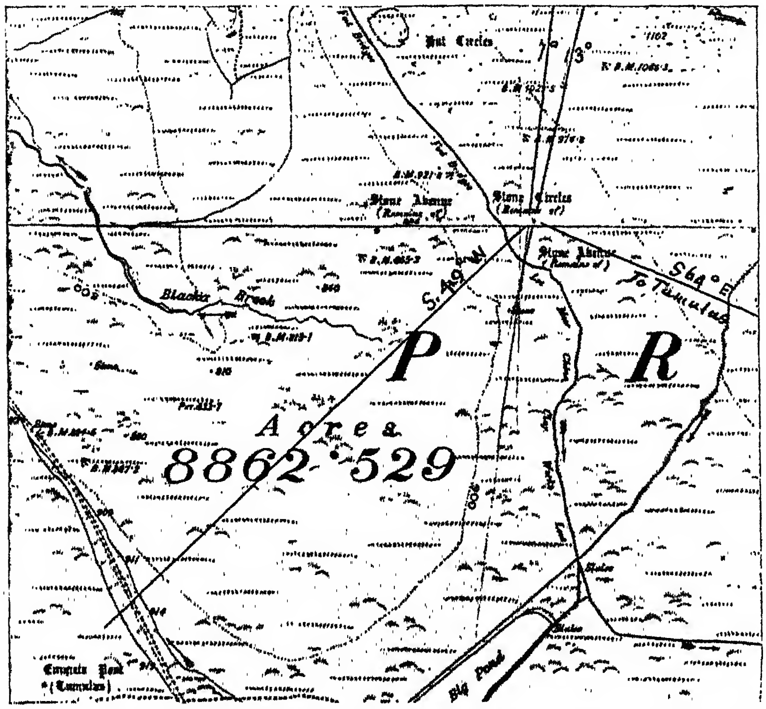


FIG. 21.—The sight-lines at Trowlesworthy, showing high northern azimuths among others. From the Ordnance map.

The height of hills is 46′; we have then :—

Az.		N. Dec.		Star		Date
		° ′ ″				
22	...	36 19 14	...	Arcturus	...	1210 B.C.
25	...	35 23 20	...	,,	...	1040 ,,
28	...	34 19 30	...	,,	...	850 ,,

Adjacent to A, B, C, is another avenue, which I will call D. Unlike the others, its northern end points 2° E. of N. Its southern end is blocked by a remarkable triple circle, the end of the avenue close to it being defined by two tall terminal stones. We are justified, then, in thinking that its orientation was towards the north; the height of the horizon I measured as 45′. It may have been an attempt to mark the N. point of the horizon.

The triple circle to which I have referred is not an ordinary circle. I believe it to be a later added, much embellished, cairn. According to Ormerod, the diameters are 26, 20, and 3 feet, and there are three stones at the centre.

All the above avenues are on the slope of the hill to the north. On the south slope we find the longest of all, as shown on the Ordnance map survey of 1885. There is a "long stone" in its centre, and at the southern end was formerly a cromlech, the "three boys." Part of this avenue, and two of the three "boys," have been taken to build a wall. The long stone remains, because it is a boundary stone!

The azimuth is 2° 30′ W. of north or E. of south. Looking N. from the long stone, the height of the horizon is 2° 30′. I think this avenue was an attempt to mark the S. point.

Trowlesworthy (lat. 50° 27′ 30″).—The remains here are most interesting. This is the only monument on Dartmoor in which I have so far traced any attempt to locate the sun's place at rising either for the May or solstitial year. But I will deal with the N.-S. avenue first, as it is this feature which associates it with Fernworthy and Challacombe, and in order that a comparison may be made I append a map showing the sight-lines at the Hurlers (Fig. 20).

As at Merrivale, the avenue has a decided "kink" or change of direction. The facts as gathered from the 6-inch map are as follows :—

	Az.	Hills	Dec.	Star	Date
		° ′	° ′ ″		
S. part o. Avenue	N. 7 E.	2 52	41 29 10	Arcturus	2130 B.C.
N. ,, ,,	N. 12 E.	2 52	41 6 20	,,	2080 B.C.

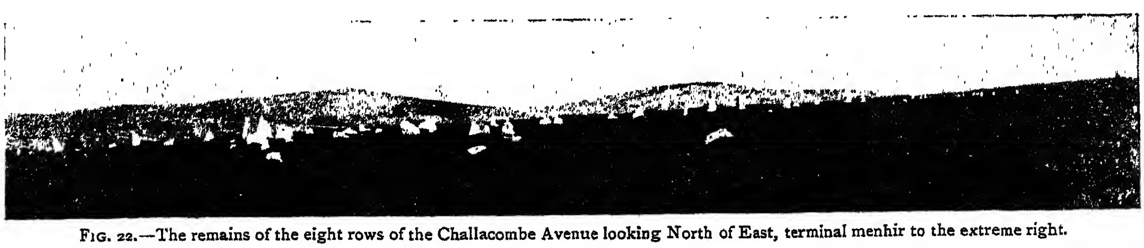


FIG. 22.—The remains of the eight rows of the Challacombe Avenue looking North of East, terminal menhir to the extreme right.

This date is very nearly that of the use of the S. circle at the Hurlers, and it is early for Dartmoor; but it is quite possible that local observations on an associated avenue a little to the west of the circle which terminates the N.-S. avenue will justify it. This is not far from parallel to that at Merrivale, but its northern azimuth is greater, so that if it turns out to have been aligned on the Pleiades its date will be some time before that of Merrivale, that is, before 1680 B.C. I can say nothing more about it until I have visited it.

The new features to which I have referred are two

tumuli which in all probability represent more recent additions to the original scheme of observation, as we have found at Stenness; and show that Trowlesworthy was for long one of the chief centres of worship on Dartmoor. Their azimuths are S. 64° E. and S. 49° W., dealing, therefore, with the May year sunrises in November and February and the solstitial sunset in December. It is probable that, as at the Hurlers, tumuli were used instead of stones not earlier than 1900 B.C.

Stalldon Moor (lat. 50° 27′ 45″) I have already incidentally referred to. The azimuth of the stone row as it leaves the circle, *not* from its centre as I read the 6-inch map, is N. 3° E.; as the azimuth gradually increases for a time, we may be dealing with Arcturus, but local observation is necessary.

The differences between the Cornish and Dartmoor monuments give much food for thought, and it is to be hoped that they will be carefully studied by future students of orientation, as so many questions are suggested. I will refer to some of them.

(1) Are the avenues, chiefly consisting of two rows of stones, a reflection of the sphinx avenues of Egypt? and, if so, how can the intensification of them on Dartmoor be explained?

(2) Was there a double worship going on in the avenues and the circles at the same time? if not, why were the former not aligned on the circles? On a dead level, of course, if the avenues were aligned on the centre of the circle towards the rising or setting of the sun or a star, the procession in the *via sacra* would block the view of those in the circle. We have the avenue at Stonehenge undoubtedly aligned on the centre of the circle, but there the naos was on an eminence, so that the procession in the avenue was always below the level of the horizon, and so did not block the view.

(3) Do all the cairns and cists in the avenues represent later additions, so late, indeed, that they may have been added after the avenues had ceased to be used for ceremonial purposes? The cairn at nearly the central point of the S. avenue at Merrivale was certainly not there as a part of the structure when the avenue was first used as a *via sacra* for observing the rising of the Pleiades. I have always held that these ancient temples, and even their attendant long and chambered barrows, were for the living and not for the dead, and this view has been strengthened by what I have observed on Dartmoor.

There was good reason for burials after the sacred nature of the spot had been established, and they may have taken place at any time since; the most probable time being after 1000 B.C. up to a date as recent as archæologists may consider probable.

Mr. Worth, whose long labours on the Dartmoor avenues give such importance to his opinions, objects to the astronomical use of those avenues because there are so many of them; he informs me that he knows of 50; I think this objection may be considered less valid if the avenues show that they were dedicated to different sacred uses at different times of the year. For instance, Challacombe is not a duplicate of Merrivale; one is solstitial, the other deals with the May year, and a complete examination of them—I have only worked on the fringe—may show other differences having the same bearing.

In favour of the astronomical view it must be borne in mind that the results obtained in Devon and Cornwall are remarkably similar, and the dates are roughly the same. Among the whole host of heaven from which objectors urge it is free for me to select any star I choose, at present only six stars have been considered, two of which were certainly used afterwards at Athens; and these six stars are shown by nothing more recondite than an inspection of a precessional globe to have been precisely the stars, the "morning stars," wanted by the priest-astronomers who wished to be prepared for the instant of sunrise at the critical points of the May or solstitial year.

NORMAN LOCKYER.

THE BOTANICAL CONGRESS AT VIENNA.

THE International Botanical Congress, held at Vienna on June 11–18, was an impressive demonstration of the activity of botany as a science, and of the enthusiasm of its adherents. Vienna is not the most central town for a meeting-place, but, nevertheless, more than six hundred botanists, men and women, representing nearly all the important, and many of the less important, botanical institutions of the world, met together there. As might have been expected, the central European element predominated, but there were a goodly number of Americans representing the southern and far western as well as the eastern States, while from the Far East came a deputation of two Chinese.

On the first day of the Congress, members were invited to be present at the opening of the Botanical Exhibition, which was held in the orangery of the historic Palace of Schönbrunn, just outside the town. The exhibition was an interesting one, and gave a good idea of the present position of botany from a teaching as well as from a more general point of view. There were fine series of diagrams, and coloured photographic lantern-slides of microscopic preparations, flowers, plant associations, and other objects; living cultures of Algæ; apparatus of all kinds; and some beautiful photographs of tropical vegetation in Brazil, Malaya, and elsewhere. A remarkable feature was the unique specimen of *Fockea capensis*, a member of the family Asclepiadaceæ, which, originally brought from the Cape, still remains the only known specimen. The plant has a hard, woody rhizome, as big as a child's head, from which in the rainy season numerous shoots are developed. It was figured and described by Jacquin in his "Fragmenta" at the beginning of the last century.

The Botanic Garden of Schönbrunn brings to mind, at any rate for the systematic botanist, the name of Jacquin, and some of his manuscript and original drawings were an important feature of the exhibition, and a subject of envious admiration of certain American botanists; we in London are proud to possess some of Jacquin's work, in the form of botanical letters to Sir Joseph Banks's librarian, Dryander, copiously illustrated with exquisitely delicate drawings. His herbarium, consisting largely of plants cultivated in the Vienna and Schönbrunn gardens, was bought by Banks, and is now in the general collection at the Natural History Museum. Nicolas Joseph Jacquin was professor of chemistry and botany at Vienna from 1768–96; later in the week of the congress a bust was unveiled in his honour in the Fest-Saale of the university. To quote from Prof. Wiesner's appreciation at the ceremony:—"His broad horizon and great powers of organisation were shown in the fact that, in the second half of the eighteenth century, no scientific, and especially no natural scientific, undertaking was started in which Jacquin did not take an important part. He embodied the ideal of the academic teacher." On the same occasion was also unveiled the bust of Jan Ingenhousz (1730–99), a Netherlander by birth, who spent the greater part of his working life in Vienna. Physician to the Empress Maria Theresa and the Emperor Joseph II., botanists know him best as one of the earliest workers in the sphere of plant

physiology; to quote the inscription beneath the bust, "Qua ratione plantae aluntur, primus conspexit."

On the evening of June 11, the members met in the Hall of the "Kaufmännscher Verein," when Prof. Julius Wiesner, the well-known head of the Institute of Plant Physiology, welcomed the botanists of the world to the home of Clusius, Jacquin and Unger; and the botanists renewed old friendships or made new ones over the Abendskarte and the inevitable *Bier*. At the official opening, in the great festal hall of the university, on Monday morning, greetings were given by the famous geologist and president of the Academy of Sciences, Prof. Eduard Suess, Prof. Wiesner, and others.

The general programme included lectures or papers by well-known men on topics with which their names have become associated. Thus Prof. Goebel discussed the subject of "Regeneration," and Dr. D. H. Scott gave an account of the present state of our knowledge of the Pteridosperms—the fern-like seed-plants of the Carboniferous flora—the illustration of which, by actual specimens, in the form of lantern-slides, was especially appreciated.

The development of the European flora since Tertiary times formed the subject of a group of papers. Prof. Engler, in stating the general problems, referred to the part played by man and his works, especially during the last century. He pleaded for the preservation of such plant-formations and plant-societies as throw a light on the past history of the European flora, citing as an example the National Park in the United States of North America. In the same connection Dr. Lauterbonn asked the help of the congress towards securing the preservation of part of the primitive forests of Bosnia, which, he stated, were in imminent danger of destruction. An interesting paper on the history of the development of the flora of the North German "Tief-land" was read by Prof. Weber. Covered by the sea since Oligocene times, this area became dry land during later Pliocene times, and the earliest vegetation of this period is remarkable for the occurrence of the vine, which is now generally regarded as an introduced plant in Central Europe. The plant-life of this area was, during the diluvial period, repeatedly crushed out of existence by land-ice, the intervening periods of vegetation being remarkable for the appearance of plants indicating a milder climate than do those composing the existing flora. Another subject, taken up by Dr. Molisch and Prof. Hueppe, of Prague, was the present state of our knowledge of CO_2-assimilation. Mention should also be made of a very fine series of photographic slides with which Dr. Hochreutiner, who has just returned from a prolonged stay in Buitenzorg, illustrated his account of a botanical institute in the tropics.

But for many of the members the most important work came in the afternoon, a time devoted by the majority to relaxation, which often took the form of excursions to places of botanical interest within easy reach of the town. Meanwhile the conference on botanical nomenclature sat in the lecture hall of the Botanic Gardens. At the entrance to the gardens is the former residence of the director, and we passed the window of the room in which Kerner wrote most of the well-known "Pflanzenleben." Kerner's successor, Prof. von Wettstein, is lodged in the new Botanical Institute—a large and well-arranged building. The arrangement of the gardens is mainly a geographical one—in one bed a collection of Himalayan plants, in another plants from the Cape, and so on. The result, though doubtless helpful to the student, illustrates the limitations to which such an arrangement is subject in any one climate. The work of the conference was to discuss the recommendations of the commission on nomenclature appointed by the International Congress of Paris in 1900. These were embodied in the *Texte synoptique*, a formidable quarto volume in which the *rapporteur général*, Dr. Briquet, had collated the numerous emendations and modifications of the original code of De Candolle, which during the last five years have been submitted by various societies, institutions, groups of botanists, and individuals. The numerous suggestions had previously been voted on seriatim by the members of the commission, and from the results of the voting certain recommendations were drawn up by Dr. Briquet for the consideration of the members of the conference, about a hundred and fifty of whom were present. The new American school was strongly represented by Dr. Britton, Mr. Coville, and others, while Dr. Robinson, of Harvard, represented the more moderate school which has worked on lines similar to those adopted in England. The Berlin school was present in force, and most of the Continental botanical societies and institutions were represented. As the president, Prof. Flahault, remarked, in answer to Dr. Otto Kuntze's protest against an "incompetent congress," it would be difficult to bring together a body of botanists more competent to discuss botanical nomenclature, and, one may add, more seemingly anxious to arrive at some solution of the various problems, and some agreement on the points at issue. From three to seven or eight o'clock each afternoon the members steadily worked through the *Texte*.

It was decided at the start to refer the question of cellular cryptogams and fossils to separate commissions, which should report to the next congress. The present conference, therefore, dealt only with flowering plants and vascular cryptogams. The results will in due course be arranged and published in English, French, and German. Brief reference may be made to the more important. The code of laws approved by the conference is based on that of De Candolle, and will consist of rules and recommendations, the difference between the two sets being expressed thus:—"A name contrary to a rule cannot be kept up; a name contrary to a recommendation is not a model for imitation but cannot be rejected." The most important result was the passing by an overwhelming majority of a list of generic names, which from long established usage are to be retained, though on the principle of priority they should be rejected. There was considerable discussion on the question as to the trivial name to be adopted when a plant is transferred from one genus to another, or from subspecific or varietal to specific rank. English, and a minority of American, botanists have followed the so-called "Kew rule" of adopting the first correct binominal, while the majority of American and most Continental botanists, in common with zoologists, adopt the earliest trivial name. On this point a compromise was effected as follows:—When a change of systematic position without change of rank occurs (such as the transference of a species from one genus to another), the earliest epithet is to be used; when the rank changes (as in the elevation of a variety to specific rank), the original epithet is not insisted on. The conference was also strongly opposed to any change in a name once given, though for various reasons it might be considered inappropriate or even misleading. A name is a name, and must stand.

An account of the congress would be incomplete without some reference to the nightly meetings for social intercourse which were arranged by the organising committee on typical Continental lines. Members will carry away very pleasant memories of the Rathhaus-Keller, the Prater, and the Brauerei garden out at Hutteldorf. For, after all, the great object of a

congress is the meeting together and getting to know one's fellow-workers; and an expression of thanks is due to the organising committee under the joint presidentship of Profs. Wiesner and von Wettstein, with Dr. Zahlbruckner as the energetic secretary, to Prof. Flahault, the firm and genial president of the conference on nomenclature, and finally to Dr. Briquet, whose name must always be associated with the latest attempt to solve the vexed question of plant-nomenclature.

At the final meeting, in response to an invitation from the Belgian Government voiced by Prof. Errera, Brussels was selected as the place of meeting for the third congress, which will be held in 1910.

A. B. RENDLE.

ENTRANCE EXAMINATION TO THE INDIAN FOREST SERVICE.

On May 11 the Secretary of State for India issued the regulations for the forthcoming entrance examinations for the Indian Forest Service. Amongst the features of these regulations two are of considerable importance.

The age limit is raised to twenty-one years on January 1 preceding the examination, so that the average B.A. who graduates usually between twenty-one and twenty-two may compete. The second point of interest is the schedule of the subjects in which he is to be examined.

According to the regulations given in the East India (Forest Service) Blue-book, Cd. 2523, the subjects in which the candidates are to be tested are four—chemistry, physics, botany, and zoology—and the schedules imply that the knowledge which the candidate is expected to exhibit is of a very limited description. Speaking roughly, the examination will be harder than the preliminary scientific examination which every candidate for a medical degree is obliged to take, but not much harder. Medical students generally pass their preliminary scientific examination during their first year, though there are cases in which they pass it while still at school. The Indian forestry students may pass their entrance examination in their third or fourth year. The Blue-book stated that each candidate must qualify in all four subjects, but for some reason or another—and probably because the entry under the new regulations is small—the Secretary of State for India has now still further lightened a very elementary examination, and is now advertising in our columns that zoology is optional. Thus men, who may be graduates, will be admitted into a great public service on an examination which comprises but three out of the ordinary four subjects which candidates for medical degrees normally pass in their first year, and judging by the schedules the amount in each subject to be "got up" is little more than in the preliminary examination for an M.B. degree.

When we remember that in the Indian Civil Service examination the standard of the subjects is that of an honours examination, and that a candidate takes not three subjects, but eight, nine, ten, or more, it is obvious that the Secretary of State is trying to recruit the forest officers from men of a markedly inferior intellectual range, and the strictures which were passed by Sir George King on the Indian foresters at the Dover meeting of the British Association will probably need repeating a few years hence.

The schedules are well adapted for an elementary pass or plough examination, but are ill adapted for a competitive examination. It will be very difficult, if not impossible, to select the best candidates competing in an examination carried on on these lines.

NOTES.

An important step in the direction of the adoption by this country of a decimal system of weights and measures has been taken by the Board of Trade. In reply to a resolution sent to the Board of Trade by the secretary of the Association of Chambers of Commerce, in which the Board was asked to authorise weights of 20 lb., 10 lb., and 5 lb. as aliquot parts of the cental, Lord Salisbury has written:—"With reference to your letter of March 14 last, in which you suggest that new denominations of weights of 20 lb., 10 lb., and 5 lb. should be legalised for use in trade, the Board of Trade have given careful consideration to the representations which have been made, and they are prepared to assent to the application. Steps will, therefore, be taken for the preparation of standards of the same octagonal form as the present 50 lb. weight." The chambers consider that this concession will save time, labour, and expense, as the 50 lb. weight has done already.

Commander Peary sailed on Sunday last to make a further attempt to reach the North Pole. Before leaving, he communicated various particulars respecting his expedition to Reuter's Agency. His plan is based upon the Smith Sound, or "American" route to the Pole, and his object is to force his ship to a base within 500 miles of the Pole itself, and then to sledge across the Polar pack. The Arctic ship *Roosevelt*, which has been specially built for this expedition, has been constructed so as to withstand the heavy ice pressure, and is so shaped that the pressure of the ice pack will have the effect of raising the vessel out of the water. The ship will carry a wireless telegraphic outfit, which, with one or two relay stations in Greenland, will keep her in communication with the permanent telegraph station at Chateau Bay, Labrador, and thence by existing lines with New York. By the same means communication with the expedition will be possible, at least for a portion of the distance, when in February next the sledge party leaves the *Roosevelt* for the northern dash. The ship will carry two years' supplies. With regard to the route to be followed, it is intended to establish a permanent sub-base at Cape Sabine, on the west coast of Smith's Sound, and, after securing the services of the necessary Eskimos, to force the vessel through Kane Basin and Kennedy and Robeson Channels to the northern coast of Grant Land or of Greenland, if the conditions should compel it, and there winter within 500 miles of the Pole. From these winter quarters a start north over the Polar pack will be made in February. The explorers will have available a probable period of five months in which to traverse the distance between their vessel and the Pole. In the event of the failure of the *Roosevelt* to force Kennedy and Robeson Channels during the first summer the dash for the Pole will have to be postponed until February, 1907.

The seventy-third annual meeting of the British Medical Association will take place at Leicester from July 24 to 28. Addresses in medicine and surgery will be delivered respectively by Dr. H. Maudsley and Mr. C. J. Bond, and, following the precedent of last year, a popular lecture will be given (on July 28) by Prof. Wm. Stirling, who will take as his subject the phenomena of fatigue and repose.

The Geologists' Association announces an excursion to Central Wales extending from July 24 to 29. The headquarters are to be at Llandrindod Wells.

The first International Congress of Physiotherapy will be held at Liége from August 12 to 15 next. The questions proposed for discussion are, says the *British Medical*

Journal:—(1) the specific indications of the several physiotherapeutic agents; (2) description of the apparatus and technique required in each case; (3) (*a*) how university teaching on physiotherapy is given at the present time in the various countries where instruction is given on the subject; (*b*) how such instruction should be given in medical faculties; (4) the indication of suitable means for the vigorous repression of quackery and the abuses caused by "healers" who pretend to treat by physiotherapeutic procedures. Papers should be sent to Dr. Gunzburg, 7 Rue des Escrimeurs, Antwerp.

THE full programme of the International Congress on Tuberculosis (meeting in Paris from October 2 to 7 next) has now been issued, and is summarised in the *British Medical Journal*. In the section of medical pathology, presided over by Prof. Bouchard, the following subjects are proposed for discussion:—(1) treatment of lupus by the new methods; (2) early diagnosis of tuberculosis by the new methods. In the section of surgical pathology, presided over by Prof. Lannelongue, the following questions will be considered:—(1) comparative study of different forms of tuberculosis; (2) ileo-cæcal tuberculosis; (3) surgical interventions in tuberculosis of the meninges and encephalon; (4) tuberculosis and traumatism. In the section of protection and assistance of childhood, presided over by Prof. Grancher, the questions to be discussed are:—(1) family protection; (2) protection in the school; (3) seaside sanatoriums; (4) school mutual aid societies and the part played by them in the prevention of tuberculosis. In the section of protection and assistance of adults, and social hygiene, attention will be directed to:—(1) etiological factors of tuberculosis, economic conditions in the social etiology of tuberculosis; (2) assurance and friendly societies in the prevention of tuberculosis; (3) the part of dispensaries and sanatoriums in the struggle against tuberculosis; (4) sanitation and healthiness of the dwelling; (5) hygiene of tuberculous persons in factories, workshops, places of business, army and navy; (6) disinfection of the dwelling of the subject of tuberculosis (administrative regulations and practical measures). In connection with the congress there will be an exposition arranged in the four following departments:—(1) scientific: a museum of microbiology, experimental, medical, surgical, and veterinary tuberculosis; (2) social: ravages caused by tuberculosis, prevention, assistance; (3) historical: tuberculosis in various ages, in art and in history; (4) industrial: prevention, alimentation, private dwellings, public dwellings (schools, barracks, &c.); travel (railway carriages, ships, hotels); assistance (hospitals, dispensaries, sanatoriums).

THE Museums Association held its annual meeting last week at Worcester; the proceedings opened on Tuesday, and on Thursday the president (Lord Windsor) delivered his address.

A TABLET to the memory of Sir Humphry Davy was unveiled by Mr. Marconi at Clifton, Bristol, on Friday last. The tablet is to be placed on 3 Rodney Place, Clifton, in which house Sir Humphry Davy lived for a time.

PROF. GUIDO CORA has been elected a member of the Pontificia Accademia Romana dei Nuovi Lincei of Rome.

WE regret to see the announcement of the death, on June 29, at Washington, of Mr. George H. Eldridge, one of the geologists on the staff of the United States Geological Survey. He contributed many valuable papers to geological science, dealing with coal, petroleum, asphalt, and bituminous rock deposits.

THE death occurred on July 10 of Sir Peter Nicol Russell, who, by his gift of 100,000*l*., founded the school of engineering of Sydney University. He was eighty-nine years of age.

THE death is announced of Mr. Charles Moore, director of the Sydney Botanic Gardens and of the Government Domain and Plantations. He had attained the age of eighty-six years.

A MEETING of the central committee for physical education in Italy took place recently in Rome under the presidency of Mr. L. Lucchini. Among those present were the Italian Under-Secretary of State for Instruction, and delegates of the Ministries of Instruction, War and Marine; there were also representatives of the municipality of Rome, the gymnastic association, and the Alpine and touring clubs of the city. The main object of the committee is to stimulate interest in the physical education of the Italian people, which, it is contended, has hitherto been much neglected.

A REUTER telegram from Penang states that the Chinese Consul of that place has offered to build and equip a Pasteur institute for the Straits Settlements and the neighbouring regions. The action has been prompted by the recent outbreak of rabies in Penang, resulting up to the present in four deaths.

BOTH Messrs. Siemens and Halske, of Berlin, and the Marconi Company are in communication with the Althing, the proposal being to establish communication by wireless telegraphy between Iceland and the Continent and internally in the island. According to a Reuter telegram, the Berlin firm offers to provide the installation for about 36,666*l*., and to guarantee the efficient working of the system.

IN connection with an exhibition to be held next year at Milan, there is to be a competition of appliances designed to safeguard against accidents, and the following prizes will be offered:—a gold medal and 320*l*. for a new device which will suppress the danger to life coming from a contact formed between the primary and secondary circuits of an electric transformer; a gold medal and 40*l*. for a crane or hoist provided with a simple and practical device preventing the rotation of the cranks on the descent of the load; a gold medal and 20*l*. for a simple, strong and effective apparatus for automatically stopping cars which are moving upon an inclined plane in case the traction cable should break; a gold medal for a practical device for exhausting and collecting the dust formed during the sorting and cutting of rags by hand; a gold medal for an apparatus for localised exhaust and successive elimination of dust produced during the cardage of flax, tow, hemp, jute, &c.; and a gold medal for an effective device to prevent the diffusion of dust in places where the preparation of lime and cement is carried on. The competition is to be under the auspices of the Association of Italian Industries, and names of competitors must be sent to the secretary at Foro Bonaparte 61, Milan, before the end of the present month.

A NUMBER of prizes ranging in value from 10,000 marks to 750 marks are offered by the Internationales Arbeitsamt, Basel, Switzerland, for essays on means of combating lead poisoning. The essays must contain proposals for the elimination of the danger to which no objection can be made on technical, hygienic, or economic grounds. In proposing new apparatus or alterations in process, particulars must be given as to the cost and saving involved in such proposals. It is desired that proposals should be

made for the improvement of existing laws upon the subject in all countries, and attention directed to the alterations which would be necessary for putting the suggestions into effect. The papers, which may be in English, French, or German, must reach the Internationales Arbeitsamt by the end of the present year.

WE learn from *La Nature* that the annual prize of the French Society of Civil Engineers has been awarded for 1905 to two men of science—to M. Alphonse Tellier for his researches on motor navigation, and more particularly for his memoir on "Les canots automobiles à grand vitesse," and to M. J. Rey for his memoir on "Les turbines à vapeur en général, et plus particulièrement sur les turbines du système Rateau et leurs applications." The Alphonse Couvreux prize has been awarded to M. F. Arnodin for his work on trans-shipping bridges. The 1905 Giffard prize will be postponed until 1908.

AT the annual distribution of prizes at Guy's Hospital Medical School last week the new Gordon Museum of Anatomy and Pathology was open to inspection. The museum is, it will be remembered, the gift of Mr. Robert Gordon, who at the distribution of prizes was presented by the governors and medical staff with a replica in silver of the statue of Thomas Guy in the hospital square, together with a bound memorial volume signed by the Prince of Wales and all the members of the governing body. The specimens in the museum now number upwards of 12,000, and their re-arrangement and classification will, it is hoped, be completed within the next few months.

PROF. A. PENCK contributes an account of the progress made in the organisation and execution of the map of the world on a scale of 1 : 1,000,000 to the *Zeitschrift* of the Berlin Gesellschaft für Erdkunde. It appears that up to March of this year the four chief organisations—French, German, British, and Indian—had completed 69 sheets out of 437 planned. A sketch map shows the sheets completed and in preparation.

THE Canadian Department of Marine and Fisheries has recently published a valuable paper by Dr. W. Bell Dawson on the currents at the entrance of the Bay of Fundy and on the steamship routes in its approaches off southern Nova Scotia. The results are based on observations made by the tidal and current survey in 1904, and show that the movements of water are chiefly tidal in character, there being no marked general movement in any one direction.

THE report on the census of the Philippine Islands, taken in March and April, 1902, has recently been issued. It consists of four volumes, comprising three thousand pages, and is freely illustrated with statistical maps and diagrams. An excellent summary of this report, which includes papers on the climate and resources of the islands besides other statistical information, appears in the Bulletin of the American Geographical Society for May, from the pen of Mr. Henry Gannett.

ALMOST from time immemorial, in a zoological sense, the South American electric eel has been regarded as the type (and sole representative) of the genus Gymnotus, as *G. electricus*, and it is thus named in the "Cambridge Natural History." In a paper on the Gymnotidæ published in the *Proceedings of the Washington Academy* (vol. vii., p. 159), Messrs. Eigenmann and Ward revive, however, an old proposal that the *Gymnotus carapus* of Linnæus should be taken as the type form, and the electric eel referred to a genus apart. They even go so far as to exclude the latter species from the Gymnotidæ altogether—a proceeding which forcibly recalls the well-known saying with regard to the play of *Hamlet*. This is, indeed, in our opinion, one of those cases in which, whatever may be original rights in the matter, everything is to be gained by adhering to established practice. In the text the authors define the different genera they include in the Gymnotidæ, describing some of these for the first time.

IN another issue of the serial last quoted (*Proc. Washington Acad.*, vol. vii., pp. 27–157) Mr. W. F. Allen records observations on the blood-vascular system in the fishes of the group Loricati, that is to say, those constituting the families Scorpænidæ, Anoplopomatidæ, Hexagrammidæ, and Cottidæ. In view of the circumstance that it is at present impossible to determine whether certain features in the circulatory system of these fishes are primary or secondary, no inductions are drawn from the observations with regard to the classification of the group. Nevertheless, it is suggested that the blood-vascular system may eventually prove to have a value in the classification of families and genera, although it would be useless in the case of species.

WE have received a copy of a circular issued by the Concilium Bibliographicum of Zürich in regard to a proposed physiological bibliography. A card catalogue of literature of this description was commenced on July 1, in cooperation with the *Zentralblatt für Physiologie*, and the support of all interested in the matter is requested. To aid the scheme a committee was appointed at the sixth International Physiological Congress held at Brussels, the names of the members of which are given in the circular.

THE annual report of the Selborne Society, published in the July number of *Nature Notes*, points to a flourishing condition of that body, although more members are required if its work is to be still further developed. Mr. W. M. Webb has accepted the office of hon. treasurer, *vice* Mr. R. M. Wattson, retired. Special attention is directed in the report to the preservation and protection of places of antiquarian interest or natural beauty in the neighbourhood of London. Among these, the proceedings of the London County Council in attempting to "beautify" Golder's Hill are criticised. "What is required is to leave the place more alone, and so to give nature a chance in it. Efforts to make things appear rustic almost invariably end by making them look artificial, and this is especially the case at Golder's Hill."

IN our notice of Sir C. Elliot's description of the nudibranchs of the Scottish Antarctic Expedition the number of species should have been given as six in place of two. Four of these species are new, two, as stated in the original notice, forming the types of as many new genera.

IN a brief note published in the *Atti dei Lincei* for June 3 Prof. Cuboni notifies the appearance in the island of Sardinia, in the district of Sassari, of a peculiar and little known disease of the olive. This disease, which is known in Italian as "Brusca," entirely despoils the plant of its leaves and fruit, and is associated with the fungus *Stictis Panizzei*. This fungus has an altogether remarkable history. It was first observed and studied by De Notaris near San Remo in 1842, and twenty years later it was found at Spezia. Between the years 1863 and 1899 no mention is to be found of its occurrence, but it suddenly reappeared in 1899 in the neighbourhood of Lecce, causing great damage to the olives of the district. The study of a fungus for which apparently very special conditions of growth are necessary seems likely to give results of particular interest in vegetable pathology.

In the *Proceedings of the American Academy of Arts and Sciences* (vol. xl., No. 23) Mr. Gilbert N. Lewis makes a study of the auto-catalytic decomposition of silver oxide under the influence of heat. It is shown that the velocity of decomposition of the oxide at a constant temperature increases as the action proceeds, and, after passing through a maximum, falls gradually to zero. The phenomenon is due to the catalytic action of the metallic silver produced, the action proceeding very regularly according to an equation representing the simplest case of autocatalysis. During the decomposition, definite temperatures between 327° C. and 353° C. were maintained by means of a thermostat containing a fused mixture of sodium and potassium nitrates. The purity and method of preparation of the silver oxide have a very great influence on the velocity of decomposition. The theory is advanced that the influence of the silver is directed in modifying the velocity of the reversible change $O_2 \rightleftharpoons 2O$.

We have received from the Medical Supply Association a pamphlet dealing with the Gaiffe auto-motor mercury-jet interrupter and its application in producing high-frequency currents. The interrupter is a simplified form of the mercury-jet turbine type, and is so arranged that the interrupter cuts off the current for both the motor and coil. The interrupter thus works automatically, and the use of an independent motor is dispensed with. The arrangement is simple, portable, and less expensive than any other form of turbine interrupter.

Some singular results obtained during the investigation of the activity of radiotellurium (polonium) are recorded by Prof. B. Walter in a paper in the *Annalen der Physik* (vol. xvii. p. 367). It would appear that the α rays of radiotellurium are capable of producing a species of fluorescence in the air through which they pass in such a manner that a radiation is set up having a pronounced photochemical action and similar properties to the ultraviolet portion of the spectrum lying between λ 350 and λ 290. The radiation is completely absorbed by aluminium foil 0·0091 mm. in thickness, but readily passes through a glass plate 0·15 mm. thick. In passing through a vacuum, however, the α rays of radiotellurium do not give rise to a radiation, whilst in gases other than air or nitrogen the effect is only very slight. The new radiation seems, indeed, to be produced only by nitrogen, the effect with this gas being thirty to fifty times as great as with hydrogen or oxygen. This fact is of unusual significance as tending to throw light on some of the peculiar properties of the nitrogen atom.

The part played by the copper salt in Deacon's process of preparing chlorine from hydrogen chloride is still uncertain, although many hypotheses have been put forward to explain it. That which has been most generally adopted assumes that cupric chloride is decomposed into cuprous chloride and chlorine, and that the cuprous chloride then undergoes re-conversion into the cupric salt under the influence of oxygen and hydrogen chloride, copper oxychloride being formed as an intermediate product. In an experimental investigation of the process published by M. G. Levi and V. Bettoni in the *Gazzetta* (vol. xxxv. p. 320) it is shown, however, that neither cuprous chloride nor the oxychloride can be used with a successful result in Deacon's process, and that the oxychloride is not convertible by hydrogen chloride into cupric chloride under the conditions in which chlorine is ordinarily formed. The hypothesis of an intermediate product is rejected and a purely catalytic action assumed, according to which the velocity of the change $2HCl + \frac{O_2}{2} = H_2O + Cl_2$ is greatly influenced by the presence of the copper salt. The catalyst is supposed to help the action by its tendency to combine with the water produced in the change.

An interesting article by M. Albert de Romeu on the industry of the abrasive materials such as corundum, emery, and carborundum appears in the *Revue générale des Sciences* for June 15.

No. 6 of vol. ii. of *Le Radium* contains a useful article by M. G. H. Niewenglowski on the development of photographic plates which have been subjected to the action of radio-active substances.

Under the title "From the Borderland between Crystallography and Chemistry," an address delivered before the Science Club of the University of Wisconsin by Prof. Victor Goldschmidt, of Heidelberg, is printed in the Bulletin of the university (No. 108). Attention is directed to the interesting results that have been obtained by studying the etch-figures and dissolution bodies of crystals and their significance in forming a mechanical theory of dissolution.

The sugar and cacao industries in the West Indies formed the principal subjects of discussion at the agricultural conference held in Trinidad in January; the proceedings in connection with these matters are reported in the first number of vol. vi. of the *West Indian Bulletin*. The condition of the sugar industry in Trinidad evoked considerable discussion, the subject at issue being the small amount of cane produced by the farmers per acre. Dr. F. Watts gave some account of the establishment of a well equipped central sugar factory in Antigua. The question of shade trees for cacao was debated, but evidence was not forthcoming to show why the shade that is considered necessary in Trinidad proves to be injurious in Grenada. Mr. L. Lewton-Brain and Mr. H. A. Ballou presented papers on the fungoid diseases and insect pests of sugar canes and cacao trees.

The route followed by Mr. B. Fedtschenko on his botanical journey through the Pamirs, as described in the *Bulletin du Jardin impérial botanique de St. Petersbourg*, vol. v., lay along the river Pianj where it runs parallel and a little to the north of the boundaries of Kashmir and Chitral; thence proceeding north the explorer returned to Osch, in Turkestan. *Anaphalis seravschanica* and *Ferula gigantea* were the most remarkable plants obtained on these stages of the journey. A malformation of the flowers of *Tragopogon pratensii* showing pedicelled florets and phyllody of the calyx is described by Mr. Dmitriew.

Mr. P. H. Rolfs presented the first results of his investigations into the diseases of citrous plants and fruits caused by the fungus *Colletotrichum gloeosporioides* in Bulletin No. 52 of the Bureau of Plant Industry, U.S.A. It is there shown that wither-tip, leaf-spot, anthracnose, and fruit canker are all due to the same fungus. Wither-tip and leaf-spot can be controlled by pruning followed by spraying with Bordeaux mixture, while spraying with ammoniacal solution of copper carbonate is efficacious against disease of the fruit. A later article in the *Florida Agriculturist* (March) deals with the appearance of these diseases on grape fruit.

The Jamaica *Bulletin of Agriculture* (May) contains an article by Mr. Fawcett on Raiffeisen agricultural banks, prompted by conditions which suggest that such a system could be advantageously introduced into the island. The

hurricane in August, 1903, caused such widespread devastation that the Government of Jamaica deemed it advisable to make temporary loans, thus assuming liabilities which would have been unnecessary had a cooperative system of borrowing money been in existence. In the same volume diverse opinions are expressed on the question of rotation of crops in connection with cotton cultivation in Jamaica. Cotton every third or fifth year, with intermediate crops of cassava or yams, maize, and legumes, is suggested; these rotations preclude the possibility of securing a second crop of cotton.

An instructive discussion of the law of biogenesis that "ontogeny repeats phylogeny" will be found in the paper forming Publication No. 30 of the Carnegie Institution of Washington, in which Mr. G. H. Shull bases his arguments upon a study of the leaf variation in *Sium cicutaefolium*. In the seedlings the first leaf after the cotyledons is extremely variable, the second leaf is generally simpler, but subsequently a pinnate leaf is developed which passes into a much dissected type. Well marked but less regular variations occur at periods of rejuvenescence and on the inflorescence. Mr. Shull concludes that ontogenetic leaf-characters afford no satisfactory clue to phylogeny, but that differentiation is due to the changed structure of the protoplasm.

"Perception in Plants" is the title of an article in *Naturwissenschaftliche Wochenschrift* (June), in which Prof. L. Kny discourses on *tropisms* and movements produced by other causes. Under heliotropism Prof. Kny mentions the views recently advanced by Haberlandt that the epidermal cells of a leaf are to be regarded as the perceptive region, and that their shape and contents enable them to act like a lens in collecting the rays of light. A photograph representing a surface view of the leaf of *Anthurium Maximiliani* tends to support this hypothesis, and also the observation that such a leaf, when submerged in water, fails to react.

We have received from Messrs. Flatters and Garnett, Ltd., 48 Deansgate, Manchester, slides exhibiting the structure of the root in the male fern and onion. They are remarkably good, and slides such as these will be of value to collections used for teaching purposes. The preparation of the material has been carefully attended to, and the details of cell and nuclear division are well shown.

Vol. i. of the report of the Royal Commission on London Traffic (appointed in February, 1903, to inquire into and report upon the means of locomotion and transport in London) has just been issued. It will be followed by seven more volumes, dealing respectively with the following subjects:—vol. ii., minutes of evidence taken, with index and digest; vol. iii., appendices to the evidence taken, and index; vol. iv., appendices to the report and index; vol. v., maps and diagrams furnished to or prepared by the Royal Commission; vol. vi., maps and diagrams furnished to the Royal Commission; vol. vii., report of the advisory board of engineers, and index; vol. viii., appendix to same.

The June issue of the *Bulletin de la Société d'Encouragement pour l'Industrie nationale* has been received. It contains a report, presented by M. A. Moreau on behalf of the Constructions and Fine Arts Committee, on "Ruberoid"; an account of a scheme for the extension of the international system to screws with a diameter of less than 6 mm.; and a paper by M. Maurice Alfassa on the organisation of labour in the United States. The economic notes, those on chemistry, and those on the mechanical sciences are as usual suggestive and interesting.

The *National Geographic Magazine* for July contains many interesting communications, among which are an address delivered to the National Geographic Society by Prof. E. A. Grosvenor on the "Evolution of Russian Government," an article entitled "The Purple Veil," the "veil" being the product of the *Lophius piscatorius*, known popularly as the "goose-fish," the "all-mouth," and the "angler," and a short paper (superbly illustrated) on "The Victoria Falls." The National Geographic Society, of which the magazine is the organ, is now housed under a deed of trust in the Hubbard Memorial Hall at Washington, the building being "in trust for the sole use and benefit of the said National Geographic Society so long, and for and during such period of time, as said Society shall continue its corporate existence under its present charter, and shall continue to use and occupy the said land and premises and the improvements thereon for the objects and purposes set forth in its certificate of incorporation."

The July number of the *Popular Science Monthly* contains an illustrated article on the University of Virginia, which, founded eighty years ago by Thomas Jefferson, has now as its first president Dr. E. A. Alderman. The illustrations contained in the paper show that the university possesses many buildings devoted to the teaching of science. Another article deals with Prof. C. A. Young, who, after more than fifty years' devotion to science, recently retired from the professorship of astronomy at Princeton University and the directorship of the Halstead Observatory.

In view of the approaching meeting of the British Association in South Africa, a special number of *Knowledge and Illustrated Scientific News* has been issued. It contains portraits of the president and of the presidents of sections, a programme of the proceedings, with a route map, and many articles dealing with South Africa and likely, therefore, to be of interest to those taking part in the association's meeting.

Mr. Murray announces "Noteworthy Families (Science)," by Mr. Francis Galton, F.R.S., and Mr. E. S. Galton. The work will form vol. i. of the publications of the Eugenics Record Office of the University of London. Another book to be brought out by Mr. Murray is "The Book of the Rothamsted Experiments," by Mr. A. D. Hall, the director of the Rothamsted Experiment Station.

Messrs. John Wheldon and Co., of Great Queen Street, Lincoln's Inn Fields, have sent us part i. of their new botanical catalogue dealing with Cryptogamia, and containing some 700 titles of books and papers.

Messrs. J. H. Dallmeyer, Ltd., have just issued their new list of photographic lenses, cameras, telescopes, prismatic binoculars, &c.

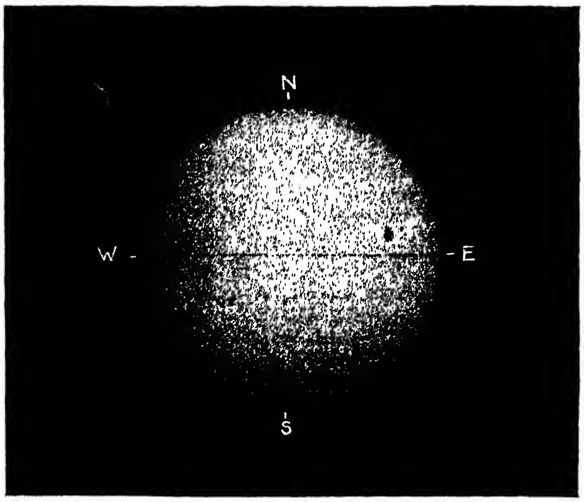
A second Italian edition of "Mattoni e Pietre di Sabbia e Calce," by M. E. Stöffler and Prof. M. Glasenapp, has been published by the firm of Ulrico Hoepli, of Milan. This edition is provided with eighty figures in the text and three folded plates at the end of the volume.

The second edition of "The Central Alps of the Dauphiny," by W. A. B. Coolidge, H. Duhamel, and F. Perrin has just been issued by Mr. Fisher Unwin. The work, which is one of the "Conway and Coolidge's Climbers' Guides" series, has been revised and brought down to the end of 1904, and the arrangement of the sections has to some extent been altered.

OUR ASTRONOMICAL COLUMN.

The Solar Activity.—The "maximum" character of the present solar-activity epoch is being well maintained by the frequent appearance of large groups of spots. Observations made on July 6 showed two medium sized spots coming round the eastern limb, and as this group travelled across the visible disc it developed considerably. On July 13 it formed a large and somewhat scattered group of which the roughly estimated extent was about 100,000 miles, and which could be readily seen by the properly protected naked eye. On July 10 this group was followed by a much more striking, although somewhat less extensive, group, consisting of two exceedingly well defined and large nuclei surrounded by well marked penumbræ and smaller spots. On July 14 both groups were readily observable with the naked eye, this being the second occasion during the present year on which two naked-eye groups have been on the solar disc simultaneously.

Single groups of this character have occurred four or five times since the first appearance of the large group in February. The accompanying reproduction shows the



forms and positions of the spots at 11.45 a.m. on Thursday last, and has been taken from a photograph secured with the photospectroheliograph of the Solar Physics Observatory, South Kensington, the primary slit being adjusted on the continuous spectrum instead of on any special line.

A Projection on Mars.—A telegram from Prof. Pickering, published in No. 4030 of the *Astronomische Nachrichten,* announces that on July 2 Mr. Lowell discovered a projection on the terminator of Mars. The object was situated near to Propontis, its position angle being 19°.

It may be remembered that in the first Bulletin issued from his observatory Mr. Lowell described a projection on the terminator of Mars, discovered by Mr. Slipher on May 25, 1903, its position angle varying from 204° to 200°. In that case the observations led to the suggestion that the projection was in reality a cloud of dust some 300 miles in extent which was travelling over the planet's surface at about 16 miles per hour (see Nature, No. 1763, vol. lxviii., p. 353, 1903).

Observations of Perseids.—Intending observers of the coming Perseid shower will probably find Mr. Robert Dole's account of his 1904 observations, published in No. 6, vol. xiii., of *Popular Astronomy,* of interest. During a total watch of 6h. 41m. on the nights of August 6, 9, 10 and 12, Mr. Dole, observing at Flagstaff, Arizona, saw 123 Perseids and 100 shooting stars, the horary rate of the Perseids being about 18·5. August 11 and 13 were completely cloudy, and consequently the observer was unable to determine the period of maximum of the shower. Some thirty of the apparent paths of the Perseid meteors were plotted, and are shown on a chart accompanying the paper.

The French Eclipse Expeditions.—Thanks to the liberality of the French Government and the activity of M. Loewy and his colleagues, French astronomy will be worthily represented amongst the expeditions which are going to, Spain, Algeria, and Tunis to observe the coming total eclipse of the sun.

Observers from the Paris and Besançon observatories will establish themselves near to Cistierna, in Leon, MM. Deslandres and Rayet are going to Burgos, whilst M. André (Lyons) will observe the eclipse at Tortosa.

The munificence of M. Bischoffsheim will enable the observers from Nice to carry out their programme on the coast near to Alcala, a station selected by M. de la Baume Pluvinel.

M. Trépied (Algiers) intends joining MM. Stéphan and Borrelly (Marseilles) at Guelma, Algeria, where MM. Nordmann and Salet (Paris) and MM. Bourget and Montangeraud, of the Montpellier Observatory, will also be located. M. Bigourdan will go to Sfax, where he intends to make actinometric observations with a Violle actinometer.

The director of the Paris Municipal Observatory, M. Jaubert, will also endeavour to make actinometric observations from the balloon *Centaure,* which is to ascend from Constantine, and a second Violle actinometer will be set up at that place for taking readings on the ground. Thermometric observations will be made on the ground and from a balloon at the Eiffel Tower, whilst actinometric observations will also be carried out at the Pic du Midi Observatory.

A Remarkable Meteor.—An unusually splendid meteor was observed by Dr. G. Johnstone Stoney on July 13.

The object was seen to traverse the eastern sky at 0h. 56m. a.m., and presented the appearance of an intensely bright and pure white globe having a diameter equal to about one-sixth of that of the moon. The meteor travelled in a N.E. direction along a path which sloped downwards, and which was nearly parallel to a line joining a point midway between α and β Andromedæ and β Persei at a distance from that line of about 12° measured along a great circle towards the south.

Dr. Stoney was not able to see the whole of the path followed by this brilliant object, but he saw it for some 30° or 35°, and estimates that his determination of the direction may be 2° or 3° in error, and of the distance of the apparent path from the reference stars, perhaps ±2°.

THE SOCIETY OF CHEMICAL INDUSTRY.

THE annual general meeting of this society was held at University College on Monday of last week. The council reported a total membership of 4326, an increase of 192 compared with the same period last year. It referred to the very successful meeting of the society in America last year, and to the pleasure felt at the visit to England of its American president, and a considerable contingent of American and colonial members. Statistics were furnished as to the number of original papers read before the various sections of the society, and reference made to the efforts of the society and its members during the year in connection with the use of duty-free alcohol for manufacturing and other trade purposes. The report of the hon. treasurer, Mr. S. Hall, indicated the continued prosperity of the society, though the cost of the journal had appreciably increased.

Mr. Gordon Salamon, chairman of the London section, next offered a welcome to the members of the society, and especially to the American and colonial members, on their assembling in London. The president then delivered his address.

Dr. W. H. Nichols, after expressing his obligations to Prof. Edward Divers, F.R.S., who had acted as deputy president during the greater portion of the year, alluded to the extension of the American membership of the society, which had been marked during his year of office by the

establishment of a New England section at Boston. He spoke of the advantage which resulted from the holding of regular meetings within reach of members as being a considerable addition to that ensuing from the possession of the valuable journal of the society, which he described as in itself worth many times the cost of membership.

Sir William Ramsay's presidential address of the previous year dealt with the results of thirty years' experience in the education of chemists, education being understood as the production of an attitude of mind rather than the imparting of definite knowledge, though the latter could not be neglected. Dr. Nichols considered the "attitude of mind" undoubtedly the pith of the matter. The young chemist fresh from college was only, after all, just prepared to learn how to apply the knowledge he had acquired, and to build on it by his daily experiences. As to some extent taking up the question where Sir William Ramsay laid it down, he proposed to discuss the question of the management of a chemical industrial organisation. The plan he proposed to outline, though it might differ widely from the views held by others as the result of their experiences, was the outcome of many years of observation and work, and had stood the test of years in a company operating more than a score of plants, widely separated and yet all working as a unit.

Below the board of directors, with its officers and executive committee, the following departments were necessary, viz.:—purchasing, sales, transportation, finance, construction, operating, research or investigation, and statistical. To harmonise these, two committees were requisite:—(1) a manufacturing committee, consisting of the managers of the operating, construction, purchasing, and investigation departments, the chairman being the chairman of the executive committee; and (2) a sales committee, composed of the managers of the sales, operating and purchasing departments, with a member of the executive committee.

The operating department was one of great complexity and importance, and needed a manager and assistant manager. Of the chemists employed, evidence is required not merely that they have received a good education and have completed a technical course of instruction, but that they are of good judgment and capable of assuming responsibility. It is desirable that they should have some knowledge of mechanical engineering and the general principles of construction, though in his experience so rare was a complete combination found that it was usually necessary to engage good chemists with but a moderate knowledge of engineering, or good engineers with only an elementary knowledge of chemistry. It was to be hoped, however, that as a result of the improved instruction in technical chemistry now being given, men would be turned out better prepared in this respect than had hitherto been the case. The great thing, however, was that the man should be practical, trustworthy, hard-working, and possessed of natural ability and the capacity for development and advancement, or, as Sir William Ramsay puts it, "have the right attitude of mind." The beginner should be kept long enough on one subject to make rapid and accurate analyses and at the same time be encouraged to make himself familiar with all the different methods of analysis bearing upon his particular work, and to be sure that he thoroughly understands the basic principles and theory upon which the work rests. After a sufficient experience along these lines, he arrives at a position where he may be able to improve existing methods or even invent new ones; but of course all new methods must be tested by rigid experiment.

In a works laboratory a variable degree of accuracy is required, depending upon the object for which the analysis is made. In some cases a tenth of 1 per cent. variation would not be serious. In other cases a ten-thousandth of 1 per cent., or even much less, is highly important, and as the object is to turn out analyses of the required accuracy in the least amount of time, it is of great advantage for the chemist to have such general knowledge of the use to be made of each analysis as will enable him to avoid waste of time in unnecessary accuracy. For routine work it is becoming more and more the custom to employ in works laboratories bright young men, graduates of high schools. Such young men are, of course, useful, but unless they pursue their scientific studies outside, as, for instance, at night schools, they are not likely to make great advances. In every laboratory there must be a chemist in control, who in turn shall be supervised by the chief chemist of the company. Unnecessary duplications being avoided, a force thus organised becomes capable of doing an enormous amount of work in a given time and with great accuracy.

The beginner confines his duties for a number of months, and frequently for years, to a works laboratory, and incidental to his analytical work he gains a certain knowledge of the general routine which obtains at that plant. After the laboratory service, if the chemist has displayed ability to advance, he is promoted to a position which will bring him into direct contact with the manufacturing processes, and his duties will gradually change from those of analyst to those of a manufacturing assistant, until he has become proficient enough to warrant promotion to the position of assistant superintendent, to which he is thereafter advanced at the earliest opportunity, either at the works at which he has received his tuition or at another works where such a position has become vacant.

The assistant superintendent is under the direction of the superintendent, and from him should receive a regular training in all the various duties pertaining to the position of superintendent, and when such a position becomes vacant, the assistant who, in the judgment of the department, is best qualified to fill the advanced position, is recommended for the promotion. The ability to administer chemical works can be obtained only by experience, and realising this fact the most efficient superintendents should act as teachers to the younger men in their development from one position to another.

Chemists who are not attracted by outside or works positions, but who prefer research work, naturally gravitate in due time from the works laboratory to the research laboratory. Occasionally one is found whose ambitions lie in the direction of mercantile affairs, for which he thinks the experience of the chemical laboratory will best qualify him. As a rule, however, the educated chemist does not select advancement in the sales department, or other business parts of the organisation, nor does it often happen that he is qualified.

The chemist, to succeed in technical work, must strive for material results. It has been my experience that the post-graduate course seems to incline him towards the search of learning rather than to its application. He must have a clear, logical mind, a singleness of purpose, and he must be able to separate the essential from the non-essential. This is true of all professions, but it is particularly true in chemical work, where the essential must be selected from an unusually large assortment of non-essentials.

The efficiency of a navy depends very largely on the "man behind the gun." So with chemists in a works or laboratory. The personal equation has much to do with the results. There is no "royal road" to success here. The rewards are for those who are willing to pay the price, and that price includes constant and intelligent work. The habit of study is rarely acquired after college days, and if the undergraduate does not develop it he should seek a less exacting profession than that of chemistry, unless his ambitions will be satisfied with the daily grind of routine work.

The investigation department is that part of the manufacturing organisation which deals with all the new propositions of a technical nature. Its work, which is entirely distinct from current manufacturing, has to do with new, and the improvement of old processes. A new proposition remains under the control of the investigation department from the time of its inception until sufficient data have been obtained to enable the construction department to design the necessary plant, if one be authorised by the executive committee. It is turned over to the operating department only after the process is working smoothly and the results considered satisfactory.

The organisation of the investigation department should be sufficiently broad to permit the consideration of a manufacturing proposition from the points of view of the business man, the chemist, the engineer, and the patent attorney. It consists of the manager, a chemical council composed

(in addition to the manager) of the chief chemical engineer, the chief chemist who is director of the research laboratory, and such consulting chemists and engineers as the company employs. The appointments in this council are intended to cover the most varied field of theoretical and technical chemistry, and the manager is permitted to consult outside experts if the company has not the necessary talent at hand. A corps of chemists on research laboratory work, an abstractor of current chemical literature, patent experts, and a small office force complete the department staff.

In the research laboratory a body of chemists, under the supervision of the chief chemist, is employed on research work connected with investigations in hand. A limited number of men are permanently retained on pure research work.

The research laboratory reports weekly the progress on all work in hand, and at the completion of each investigation sends in a statement of the steps taken, accompanied by the chief's recommendation as to further action. These reports are passed upon by the chemical council at its regular meetings.

All the analyses required are made by the analytical laboratory, which is specially equipped for turning out quick and accurate estimations. Each works has its own analytical laboratory, but there is a central laboratory for the work of the head office. This laboratory critically examines and selects all analytical methods, which are adopted as standards and furnished to all works laboratories.

The work of the investigation department originates from sources which may, in a general way, be divided into three classes:—

(a) The probability of reducing manufacturing costs.

(b) A decision to produce well established products not previously manufactured by the company.

(c) New applications of science to industry.

(a) The largest field is perhaps that of improving the processes at present in use at the different works, and is one which usually yields very profitable results. Aside from the chronic aim of the operating department to secure uniformly low costs, a decision to investigate a process in use may result from a drop in the market price of a product on account of trade conditions, or because the process is technically unsatisfactory. There may be developed, therefore, new methods or important modifications involving reconstruction or even new plants.

(b) Consideration of the manufacture of products not previously produced by the company is usually given as a result of market conditions or special wants of customers. Where a large consumption of a product of interest is developing, and the raw materials prove to be available, an investigation may be undertaken with a view to the selection of a process and the construction of a plant.

(c) The third source of investigation originates in the distinctly new processes so frequently offered to the world. Such processes, whether for a product manufactured by the company or of prospective interest, are always given the attention which their merits seem to warrant. No one who has a sensible process to offer is refused a hearing, and the treatment accorded the inventor soon becomes public opinion. As a rule, the inventor is retained to direct the development of his process under the management of the department.

As an investigation of a new manufacture includes a thorough examination of both the commercial and technical sides of the proposition, the commercial side, in which the assistance of the manager of the sales department and other commercial branches is invoked, calls for consideration of the following:—

(1) Its relation to the interests of the company; (2) the market; (3) manufacturing costs; (4) investment necessary; (5) source of raw materials; (6) transportation.

On the technical side a study must be made of:—

(1) The process; (2) other processes; (3) raw materials; (4) quality of product required.

These topics indicate the method of working out or testing the practicability of the process. This phase of the proposition is entirely a chemical and engineering one, and calls for most of the work of the investigation staff.

In the usual order of procedure, a proposal reaching the investigation department is subjected to a preliminary consideration, and is entered for record if it is to be made a subject for investigation. It is then submitted to the chemical council, which decides on the method of investigation to be pursued. A *résumé* of the literature is generally made and a report obtained from foreign representatives on the latest European developments. We may soon have to add the Japanese. As the inquiry progresses, the chemical council, which meets weekly, is kept informed of the progress made.

The thorough consideration given at this early stage frequently prevents useless laboratory expense and much loss of time.

Where an investigation of a process in use is being made, a member of the investigation department is sent to each of the works using it, to study the methods and management and analyse its defects. His reports thereon are considered by the chemical council in the manner indicated above.

If the final result of the investigation of a new process be favourable, an experimental plant may be recommended and an appropriation asked for. This may be advisable not only to assist in reaching a decision regarding the wisdom of adopting the process, but also for furnishing data for the designing of a manufacturing plant, if one be ultimately decided upon.

In the case of the adoption of a process and the designing of a plant, the work of the investigation and construction departments is very intimately connected. An investigation covers the inquiry regarding the proper design of the apparatus or plant, as well as the process *per se*

Investigations in connection with construction naturally differ, to a certain extent, and include consideration of methods for handling the raw material, the solids, liquids and gases involved in the process; furnacing, dissolving, filtering, evaporating, crystallising, distilling, subliming, drying, &c., and the packing and handling of the finished product.

The materials to be used in different parts of the construction are determined if an investigation into that important side be necessary, whether wood, cast iron, steel, lead, tin, aluminium, alloy, earthenware, porcelain, rubber, cement, &c. Any special data requested by the construction department in carrying out its work are furnished by the investigation department, such as the selection of fuel for special work, boiler and engine tests, consumption of steam, &c., and all chemical work.

The benefits resulting from organisation in the consideration of improvements and new processes are very evident. The results of experiments in one instance are applicable to others of distinctly different character. The full use of them demands a central bureau and clearing house of information.

The conferences held so frequently are not permitted to drag. Records are kept of all decisions, and even the local heads of departments present are notified in writing.

The routine work of the department consists in the collection and filing for easy access of technical and commercial data of all kinds connected with chemical manufacturing, for immediate and prospective use. Circulars containing useful information applicable to the works, and copies of research reports that may help operations, are transmitted to superintendents. Records of failure are just as important as those of success. Every encouragement is given superintendents to confer freely on any modifications, developments, or conceptions which may occur to them. The *esprit de corps* resulting naturally reaches the junior men and foremen, so that a keen sense of responsibility and importance is felt throughout.

The frequent visits of managers and superintendents to the head office, and the periodic meetings of superintendents which are called for conference and discussion enable the responsible men to continue in perfect familiarity with the technical resources of the company.

The research department would not be complete without a laboratory plant, large enough to work out processes on a small manufacturing scale. Such a plant should have all the standard appliances, and be so arranged that the results obtained in it are sufficient to form the basis for the engineering work resulting in the experimental plant to follow the successful investigation.

After all the organisation has been perfected and the machinery lubricated and put in motion, it would be apt to run wild if some trustworthy and absolute method of control should not be at hand. This I have found completely accomplished by a department which has to do with the compilation of facts and the deductions from them. It is absolutely essential, in a company operating a number of plants, that those in control should not only know what each one of its manufactured products costs, but what enters into making up that cost, so that if for any reason there is a drain going on it will be quickly known, located and stopped; or if, on the other hand, something advantageous shall have been accomplished, that will also be noted and imitated at other points. This may seem like an exceedingly difficult undertaking in an industry of such infinite variety, but a brief consideration will show that it is not so. The statistical department, to which I allude, is not only able to advise the officers within a reasonable time after the end of each month of the cost of every product and step, but also of the profit or loss on each article and the total profit or loss of the company. These results have been so exact that for several years the profits determined by public accountants at the end of the year have not varied 1 per cent. from those which had been worked up in this statistical department month by month. The importance of this information to those in control will be readily understood. For my own part, I do not see how it would be possible intelligently to run a large enterprise involving a number of plants without some such arrangement.

The exact plan which I would recommend is as follows:—

Each factory furnishes monthly the following reports:—raw materials received; raw materials used; shipments of finished products; stocks of raw materials; stocks of finished products. Productions and statement of statistical charges (including manufacturing labour, labour on repairs, material taken from the storehouse for repairs, all material taken from the storehouse for manufacturing except fuel and raw materials), packages, dry barrels, &c., included in the selling price and not returnable, manufacturing cartage (*i.e.* teams used around the works), steam and water.

The first shows the number of pounds of raw material received, together with cost of placing in the pile, and by adding the amount of bills, freight, &c., we get the actual cost per hundred pounds of each. These figures are used in obtaining the material cost of each hundred pounds of production, which, with sundries, labour, fuel, and repairs, makes up the total manufacturing cost, and in connection with that shows what each department has accomplished during the month.

As each of the factory sheets is checked and every pound of raw material and finished product accounted for, nothing escapes which should be considered in costs.

In addition to the manufacturing cost are shown the cost per 100lb. of special factory charges (including such accounts as docks, dredging, fire equipment, laboratory, lighting, roads, maintenance of yards, watchmen, gatemen, &c.), and cost per 100lb. of goods produced due to salaries of superintendents and chemists, based on proportion of labour of each department and the total manufacturing labour.

The factory shipment sheets are checked with the accounting department as well as repairs and net selling prices obtained, lighterage, cartage, allowances, estimated freights, &c., being deducted.

By using the manufacturing costs and the net selling prices, we arrive each month at the gross manufacturing profits, and deducting taxes, insurance, office, and other general expenses, the net results are obtained.

All organisation, whether in the chemical industry or any other, would fail to attain the best and most permanent results if the personal equation be forgotten. We are not dealing with a collection of apparatus, but with an organisation of men, everyone an individual, with his own peculiarities and ambitions. The day has not come, if it ever will, when from purely altruistic motives a man will give his most efficient services. He must realise that while his best work must be done, it will not go unnoticed and unrewarded. He must be sure that he will receive just and proportionately liberal treatment. His proper ambitions must not be smothered, they must be directed. From an experience of many years, I believe the plan outlined above provides fully for this most important fact, and I can point with the greatest pleasure to many men as proof of my statement, and every one more enthusiastic than at the beginning. The places of the leaders will someday be vacant. Who, then, shall fill them? Those whose lives have been spent in preparation for the work, and who will enter into it without shock or derangement of existing conditions, but as naturally as the stream flows into the river. Thus will the natural ambition of the young man reach its fulfilment in due time, and thus will our beloved industry progress to points of attainment which some of us may dream of, but will never see.

A vote of thanks to the president for his address was then proposed by Prof. Divers and seconded by Sir Henry Roscoe, the first president of the society, in the course of which allusion was made both to the valuable character of the address to which the members had just listened, to the origin of the society some twenty-five years ago, and to the considerable growth in its membership which the council's report indicated. In responding, Dr. Nichols spoke of the advantage which ensued to the society as a whole as a consequence of the visit last year to America, followed, as it happily had been, by the present visit to England of a considerable number of members from the other side of the Atlantic. He said how much he and his fellow-countrymen appreciated the hospitality that had been already shown them, and the efforts that had been made in connection with the interesting and lengthy programme that had been arranged largely for their benefit. He said that in New York they had been anxious to provide some souvenir of their visit that they might leave behind them, and, on informing the meeting of the report of the scrutineers, which declared that Prof. Divers, F.R.S., had been elected president for the ensuing year, he desired to place in his hands the little thing that they had ventured to have prepared. This was a presidential badge formed of a medallion of Sir Humphry Davy surrounded by an emblematical device representing the union of England and America in the pursuit of chemical science. He trusted that the council of the society would authorise the wearing of the badge by all his successors in the office of president, and hoped it would help still further to cement the good feeling and cordiality which existed between members of this great society on both sides of the Atlantic. He concluded by announcing the names of the vice-presidents and ordinary members of the council who had been found to be duly elected to office.

Prof. Divers expressed, on behalf of the society, appreciation of the kindness which had dictated the offer of this valuable presidential badge.

On the motion of Dr. Bailey, seconded by Mr. Hübner, who on behalf of Manchester promised a very hearty reception, it was resolved that the next annual general meeting should be held in that city.

On the motion of Prof. Chandler, of Colombia University, seconded by Sir Boverton Redwood, the hearty thanks of the society were accorded to the senate and council of University College for granting permission to the society to meet in that building. This was responded to by Sir William Ramsay, who incidentally referred to the fact that University College as a separate corporation had just ceased to exist, having become absorbed in and an essential part of the University of London. The meeting then adjourned.

THE UNIVERSITY OF SHEFFIELD.

As has already been noted in these columns, the new buildings of the University of Sheffield were on Wednesday of last week opened by the King and Queen, and by the act a new centre for research was created in this country.

Nothing seems to have been lacking to make the ceremony a success; all taking part, from the King downwards, entered into the proceedings with enthusiasm. In replying to the address of welcome presented by the city, the King said that he and the Queen were glad to be present to open the university buildings and to inaugurate a work which he was assured would tend to promote the

advancement of knowledge and the spread of culture among all classes in the city. He had no doubt that the establishment of the university would also afford facilities for the technical training which is now essential to success in every industrial enterprise, and concluded by saying that he should follow the progress of the university with warm interest. It may be mentioned here, as indicating His Majesty's interest in the spread of university teaching, that he has since sent through Lord Londonderry a letter to the Lord Mayor of Sheffield stating that "the opening of the new university buildings was felt by their Majesties to be an occasion of great importance. His Majesty has recognised with pleasure the desire felt in some of the great centres of industry and commerce that universities should take a prominent part in the promotion of scientific knowledge and research. . . . His Majesty recognises that in these days of constantly increased application of science and of scientific method to every department of modern life, it is to the universities that the nation must largely look for maintaining that position in relation to great commercial and industrial problems which is essential to the social well-being of his Empire."

His Majesty has also sent the following reply to the address presented to him by the university authorities:—"I view with lively satisfaction the establishment of this and other universities in large industrial centres, and it gives me great pleasure to open the handsome and spacious buildings provided for the University of Sheffield. I have never ceased to watch with great interest the great development of the wide movement for the encouragement of a sound and liberal education among all classes of my people, and I am well assured that the expectations of those patriotic and enlightened men by whose efforts were established the institutions from which the University of Sheffield derives its origin will be justified by the achievements of those who are educated within these walls."

The opening ceremony was preceded by the reading of the above-mentioned address from the University by the Chancellor—the Duke of Norfolk—from which we extract the following sentences:—"We bear in proud and grateful memory the fact that on more than one previous occasion members of your Royal House have shown an interest in the instructions from which the University of Sheffield derives its origin, and we gladly recall what has been already achieved in the course of your reign to advance that wider movement of which this university is but a sign and symbol. The early years of your Majesties' reign must always be remarkable as having witnessed that more general awakening on the part of your Majesties' subjects to the advantages of higher education in all branches of learning and that better understanding of its needs and requirements which is evidenced by the almost simultaneous creation of five independent universities, at Birmingham, Manchester, Liverpool, Leeds, and Sheffield. The distinction conferred upon the inauguration of our university by the gracious presence of your Majesties here to-day is of the happiest omen for its future, and we can only hope and pray that the teaching given within these buildings, the learning acquired within these walls, and the influences that will follow from them, may prove not unworthy of the great honour you have done us, and may be a constant source of profit and of ever-increasing usefulness to all classes of your Majesties' loyal and loving subjects within these districts."

The Duke of Norfolk then addressed the King, and in the course of his remarks, after paying tribute to the men to whom the university movement in Sheffield is mainly due, stated that it was now three years since it had been thought necessary to gather into one home the various sources of educational work which the university ought to supply; and the faculties of arts, of pure science, and of medicine have now been gathered together. Applied science is in another very adjacent building. He stated that every class in Sheffield has shown keen interest in the work, and that the sum of 20,000*l.* is needed to meet the expense of erecting and endowing the university.

Reference having been made to the granting in May last of the charter to the university, the King was handed a key and requested to declare the university open. This he did, speaking as follows:—"I have great pleasure in declaring these beautiful buildings open; and it is my fervent hope and desire for the long-continued prosperity of the University of Sheffield."

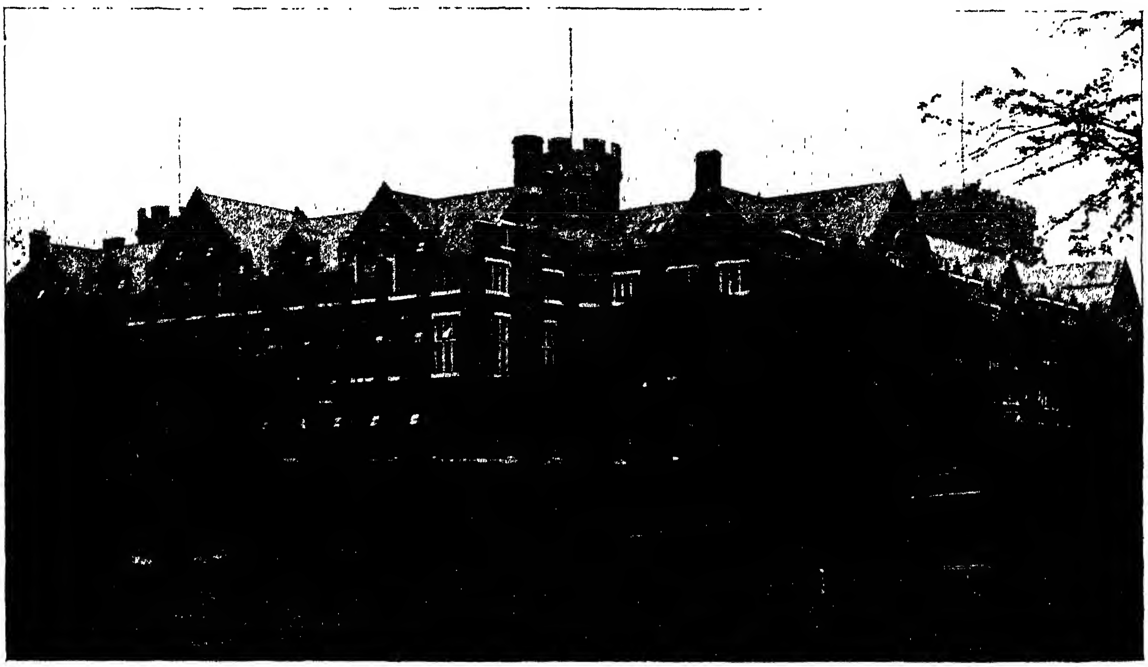


Photo. by Pawson and Brailsford, Sheffield.

FIG. 1.—The University Buildings from Weston Park.

The following is a short description of the new buildings. The illustration (which we are able to give by permission of Messrs. Pawson and Brailsford, of Sheffield) is a view of the university from Weston Park.

The buildings are constructed of red brick and stone in the Tudor style of architecture, form three sides of a quad-

rangle, and are situated upon a site overlooking Weston Park. A tower has been erected at one corner of the quadrangle, octagonal turrets at two of the other corners, the site of the third turret together with the fourth side of the quadrangle being left vacant in order to provide for future extensions. The building on the south side, which faces Western Bank, contains the large hall of the University; this hall is to be known by the name of the Firth Hall, after the founder of Firth College. The Firth Hall is designed to accommodate an audience of about 800 persons. In the same building are the administrative offices, the council room, the common rooms and refectories. The building on the west side provides for the departments in the faculties of arts and pure science, that on the north for the departments in the medical faculty. The faculty of applied science is located on a separate site about four minutes away in St. George's Square.

The physical laboratories contain a superficial area of 10,000 square feet, and are self-contained on three floors connected by a spiral staircase and apparatus lift, the rooms on each floor being arranged on either side of a central corridor except those on the lower ground floor, which, owing to the slope of the ground, are confined to the quadrangle front. Accommodation is provided for all the various departments of physics, except electrical engineering, which is housed in the buildings for applied science in St. George's Square.

The chemical department occupies the northern half of the top floor in the western block, and has a floor area, including corridors, of 7400 square feet. Two lecture theatres are provided. The larger, 30 feet by 40 feet, is furnished with seating accommodation for 110 students. A preparation room for lecture experiments adjoins this. On the other side of the corridor is a smaller lecture theatre to accommodate 34 students; this will be utilised for tutorial work, and for work with small classes.

There are laboratories for elementary and advanced students, and a small one for research work.

The biological department, which includes the two subjects of zoology and botany, adjoins the chemical department, and occupies the southern half of the top floor of the west wing. A lecture room is also allotted to this department on the first floor, and the whole of the upper part of the tower. There are two lecture rooms, the larger having accommodation for about 80 students. The general laboratory, with a raised platform and table for the purpose of practical demonstrations, and the botanical laboratory afford accommodation for 30 students each; there is also a zoological laboratory for advanced students, besides zoological and botanical research laboratories.

The anatomical department includes a large lecture theatre, a museum, several research laboratories, and private rooms for the professor and demonstrators. Accommodation for microscopes and stereoscopes is provided, also a set of the most modern anthropological instruments, and requisites for students who may desire to do work in modern developments of anatomy.

The physiological department has an area of about 5400 square feet. There are nine rooms in the department, and no corridors, the rooms opening into each other; the three largest of these are the general laboratory, 70 feet by 25 feet, the chemico-physiological laboratory, 50 feet by 25 feet, and the lecture theatre. Another large room in the department is the general research room, 25 feet by 30 feet. The rooms in this department, like all the other rooms on the north front, are lighted with specially large windows in order to facilitate microscopical work, and have several concealed sinks in the floor, which, when opened, reveal supplies of gas, water, and electricity, thus avoiding the necessity of fixed benches, their place being taken by movable tables.

The pathological department occupies the whole of the upper floor of the medical block; the main feature is the large students' laboratory facing north, 70 feet by 26 feet, divided by two partitions. There are adjoining this two laboratories, one large and one small, intended for the bacteriological work to be done in connection with the City Health Department. A special feature consists of an incubating room in the centre of the department, so arranged that it can be kept at a constant temperature; this room will replace the ordinary incubating ovens. There is a large lecture theatre in the department, a museum with a top and a south light, a special research laboratory, also private rooms, photographic and store rooms—the last two mentioned being in the roof and the turrets above the department.

The new buildings allotted to the engineering department consist of four floors; the lowest floor or basement contains a large extension of the original laboratories. The main engineering laboratory contains a plant which can be used both by mechanical and electrical engineering students. There is also a very complete electrical equipment in the new building to demonstrate the applications of electricity to lighting, traction, and power transmission.

The department of metallurgy has had special attention paid to it, seated as it is in a city where the chief national metallurgical industry is carried on. As a natural consequence of this, so far as iron and steel metallurgy is concerned, the metallurgical laboratories of the University of Sheffield are unique. These laboratories are divided into two sections, the scientific and the practical. In the first named there are nine, and in the second two laboratories.

GEOLOGICAL NOTES.

AMONG recent publications of the Geologische Reichsanstalt of Vienna, Herr G. Geyer (*Verhandlungen*, 1904, p. 363) discusses the nature of the pre-Jurassic floor of Austria, from a study of blocks of crystalline rock embedded in Liassic sandstone, and of the island-like "Klippe," formed of granite, which lies N.W. of Weyer, and which has been utilised for the memorial of von Buch. This mass of granite, by-the-by (Toula, *ibid.*, 1905, p. 89), was correctly appreciated as a projecting mass of older land, and not as an erratic block, by von Hochstetter as far back as 1869. Herr Geyer refers to many instances of "exotic blocks" north of the Alps, and points out the influence of the old gneissic and granitic foundation on the subsequent folding in the region of the Enns. Herr R. J. Schubert (*ibid.*, 1904, p. 461) adds greatly to our knowledge of the Upper Eocene and Oligocene beds of Dalmatia, while Dr. Franz Kossmat (*ibid.*, 1905, p. 71) shows how the Sava began to flow eastward on the uplifted floor of a Miocene gulf, and formed the plain near Laibach by filling in a depression that developed during the latest movements of the Alps. In the department of palæontology, Dr. Katzer (*ibid.*, 1905, p. 45) furnishes an interesting account of the microscopic structure of the Devonian Tentaculite-limestones of Bohemia, which may be regarded as a valuable supplement to Novák's work on Tentaculites (*Beiträge zur Pal. Oesterreich-Ungarns*, ii. Bd., 1882). Herr Theodor Fuchs (*Jahrbuch der k.k. Reichsanstalt*, 1904, p. 359) reviews in considerable detail a number of recent papers on fucoids, and concludes that these problematic organisms were not washed into the strata after the manner of floating seaweeds, but arose where they are now found. He insists that museum-specimens in such cases are likely to be misleading, and that a study of fucoids in the field shows that some, at any rate, run perpendicularly to the strata by which they are surrounded. Herr G. Stache (*Verhandlungen*, 1905, p. 100) again investigates the globular Cretaceous organism named by him Bradya, and gives it new interest by showing its resemblance, in structure and mode of occurrence, to Brady's recent genus Keramosphæra, described in 1882 from the deep sea south of Australia. Bradya has long been connected with Steinmann's hydrozoan form Porosphæra; but Stache is now able to revive it, and once more to refer it to the foraminifera. Students of our well known British form Parkeria will find much to interest them in this paper. Herren Hofmann and Zdarsky (*Jahrbuch*, 1904, p. 577) discuss and illustrate the dentition of Deinotherium, and the abundant remains of a species of antelope, from the Miocene beds of Leoben.

The *Transactions of the Geological Society of South Africa* for January to April contain several stratigraphical and structural papers by Dr. Molengraaff and others; but general interest will be raised by the illustrated description of the great Cullinan diamond, by Messrs. Hatch and Corstorphine, on p. 26. In the *Transactions of the South African Philosophical Society*, vol. xvi. (1905), Mr. Rogers

(p. 1) confirms his discovery of a glacial conglomerate, the Pakhuis bed, in the Table Mountain series near Clanwilliam. A thousand feet of sandstones, probably fluviatile, overlies these glacial strata, and the Devonian Bokkeveld beds follow, so that the antiquity of the conglomerate, as compared with the well known Dwyka beds, is put beyond a doubt. Mr. Schwarz (*ibid.*, p. 9) makes a block of gneiss from the volcano of Tristan d'Acunha serve as the text for a dissertation on oceanic islands in general, which he expands further into a treatise on several points in theoretical geology. We confess to a feeling of nightmare, as the one innocent specimen leads us on into enormous fields of speculation, where a considerable area is occupied by the slaying of the slain. When, after twenty-six pages, we reach the question, "What, after all, are volcanoes?" we are tempted to turn over the next eight, to where the description of "the rocks of Tristan d'Acunha" nestles humbly as an appendix. Mr. A. L. du Toit (p. 53) furnishes a serious paper on the forming of the Drakensberg, which summarises many recent observations. Stress is laid on the numerous volcanic necks and lava-flows, which are later than the Cave Sandstone. In some cases, the vents contain no igneous matter, but merely masses of exploded sandstone and shale, in a ground of pulverised grit. Dr. R. Broom re-opens (*ibid.*, p. 73) the whole question of the age and affinities of Tritylodon. Those who were present at the memorable meeting in London in 1884, when Owen laid upon the table what was believed to be the oldest known mammalian skull, will read with some surprise of the doubt which hangs over the locality and horizon of the fossil. Dr. Broom believes that it came, as then stated, from Basutoland; if so, it is from the Stormberg beds, which he regards as of Lower Jurassic age. As was pointed out in NATURE, vol. lxxii. p. 36, the reference of the reptilian beds of South Africa to the Permian may carry back the Stormberg beds also, and this will make Dr. Broom's defence of Tritylodon as a mammal, and not a reptile, of even greater interest as research goes on.

Dr. A. E. Salter (*Proceedings of the Geologists' Association*, vol. xix. p. 1) produces a large amount of original evidence bearing on the sources of the superficial deposits found above the Jurassic and Cretaceous strata to the south, north-west, and west of London. The area studied is a wide one, and Dr. Salter traces fluviatile action in it to an epoch before the deposition of the "Boulder-clay." Among his interesting conclusions, we note that a large amount of "drift" material in the lower basin of the Thames is of southern origin, suggesting that "the southern slope was formerly more extensive than at present," the distribution of such material having been probably aided by earth-movements. In support of this latter contention, it is shown that Lower Greensand chert from the Wealden area occurs 650 feet above the sea at Goring Gap. The Lower Thames Valley is thus held to be of recent geological age (pp. 17, 25, &c.). Other evidence is adduced of the modification of the general direction of drainage by earth-movements since the higher gravels were deposited.

Dr. O. Mann begins, in the *Sitzungsberichte der Gesellschaft Isis* (1904, p. 61), what promises to be a detailed account of the tin-deposits of the Erzgebirge, including a microscopic examination of the veins of quartz, tourmaline, and cassiterite.

Dr. J. W. Spencer further emphasises his views as to submerged river-channels and continental shelves in two notices of the work of Hull and Nansen (*American Geologist*, vol. xxxv. pp. 152 and 222). He provides us also with a useful bibliography of the subject in relation to America (*American Journal of Science*, vol. xix. p. 341).

A preliminary note on the geology of the provinces of Tsang and Ü in Tibet, by H. H. Hayden (*Records, Geol. Survey of India*, vol. xxxii. p. 160), forms a pleasant outcome of the recent political expedition. Marine Cainozoic beds are found north of the Sikkim border, and there is evidence of a former considerable extension of glaciers northward from the Himalayas. The granite near Lhasa is intrusive in a wide area of Jurassic strata, which have suffered much from crushing and metamorphism. The country does not appear rich in minerals, and even the gems are imported.

G. A. J. C.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Amongst the list of donations to the university benefaction fund which was recently published by the Vice-Chancellor the following sums may be mentioned:—the Right Hon. Lord Rayleigh, 5000*l.*; the Right Hon. Lord Iveagh (further donation), 1000*l.*; C. J. Heywood, Esq., 100*l.*; J. Lumb, Esq., 100*l.* Besides these a number of smaller sums have been received, some of which are especially allocated to the Huddersfield lectureship in pathology. In addition to these sums the Cambridge University Association has collected more than 6000*l.* towards the fund for the university library. The success of this is due almost entirely to the energy of the registrary. The Schuter scholarship in St. Bartholomew's Hospital has been awarded to Mr. R. B. S. Sewell, late scholar of Christ's College.

DR. T. G. PINCHES has been invited to join the staff of the institute of archæology of the University of Liverpool as assyriologist.

THE resignation of Mr. H. J. L. Beadnell from his position on the Geological Survey of Egypt is announced. Mr. Beadnell has been connected with the survey since 1896, *i.e.* from the time it was established.

FROM a long list of recent changes we extract the following appointments to professorships at technical colleges:—Prof. M. Disteli at Dresden, for descriptive geometry; Mr. Camillo Körner and Prof. K. Zsigmondy at Prague, for machine construction and mathematics respectively; Dr. Leo Grünmach at Berlin; Dr. Gustav Rasch at Aachen; Dr. Clarence Feldmann at Delft, for electrotechnics; Dr. A. Tobler at Zurich, for applied electricity; Prof. F. Schilling at Charlottenburg, for geometry. W. König, of Greifswald, has been appointed professor of physics at the University of Giessen, and Dr. Karl Stöchl professor of mathematics and physics at Passau.

THE proposal made by the Emperor of Germany for the temporary interchange of professors with America for a course of lectures is leading to a number of important results. Harvard University has invited Prof. Ostwald, of Leipzig, to give a half year's course, Columbia University has secured lectures from Prof. V. F. Bjerknes, of Stockholm, on "Fields of Force," and from Prof. H. A. Lorentz, of Leyden, on "Extensions of Maxwell's Electromagnetic Theory." Is Great Britain with its usual insularity going to keep aloof from the new movement? It is hardly likely that any proposal from our country would fail to obtain hearty support either in Germany or in America.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—"The Rate of Transmission of the Guatemala Earthquake of April 19, 1902." By R. D. **Oldham.**

This paper contains a complete study of an earthquake from the point of view of the rate of transmission. The time and place of origin are known with a sufficient degree of accuracy, and the shock was of sufficient power to give distinct records even at 160° from the origin. Three phases of wave motion are recognised, the third phase including all those which are distinguished in Japan by the symbols P_3 . . . P_8, as the author believes that it is doubtful whether there is any real difference in the character of the wave motion, or whether, in these so-called phases, we have not waves of essentially similar nature, but varying rates of propagation. The first and second phases are, however, of distinct character, being mass-waves, differing from each other not only in rate of propagation but in character of wave motion. Of these, the first phase shows a continuous increase in the apparent rate of propagation as the distance from the origin becomes greater, and seems to emerge almost simultaneously at all points more than 145° from the origin. The second phase shows an increase in the apparent rate of propagation up to 100°, and a decrease beyond this; the result is unexpected, but the author, while remarking that it must not be rejected on that

account, also points out that the second phase is much less well marked in the distant records than in the nearer ones. From the figures given in the paper, it appears that the times taken by the three phases of wave motion to travel from their origin to its antipodes are respectively about 20, 50, and 100 minutes.

Physical Society, June 30.—Dr. R. T. Glazebrook, F.R.S., past-president, in the chair.—The comparison of electric fields by means of an oscillating electric needle: D. **Owen.** This paper describes experiments which show how an "electric needle" may be used to measure electric fields in a manner similar to that in which a magnetic field is measured by an oscillating magnetic needle. The needles used were cylindrical in form, of aluminium or of brass, and were suspended by quartz fibres three or four inches in length. The couple on the needle when disturbed from the direction of the field is proportional to the square of the field strength. For small displacements the needle vibrates isochronously, the frequency being proportional to the electric force. It may be used in alternating as well as in steady fields, and may be applied to illustrate many of the laws of electrostatics. The disturbing effect of the needle upon the field is considered; in particular its effect when placed in a uniform field. It is shown by experiments that the disturbing effect falls off rapidly with the distance from the needle, and is inappreciable (in the case of a needle 1½ cm. long) at a distance of twice the length of the needle. With regard to the effect of the dimensions of the needle upon the frequency (for given field), while the restoring couple decreases rapidly with decrease of size, yet the moment of inertia decreases more rapidly, so that the smaller the needle the greater the frequency, and also the smaller the disturbing effect. The shielding effect of some dielectric materials was examined in the following way:—A needle was suspended centrally in the uniform field between a pair of parallel plates. A thin-walled cylinder of the dielectric was placed around the needle, and the shielding action denoted by a fall in frequency of the needle. Glass and mica were found to effect perfect shielding. Ordinary paper shields; but when thoroughly dried by heat the electric field is transmitted undiminished only to fall off to zero after a minute or two's exposure to the air. Dry paper soaked in melted paraffin-wax transmits the field perfectly and for an indefinite time. The paper concludes by pointing out that an electric needle suspended between a pair of parallel plates forms a simple means of measuring high voltages, since the frequency of vibration is simply proportional to the voltage between the plates.—The magneto-optics of sodium vapour and the rotatory dispersion formula: Prof. R. W. **Wood.** It has been shown in a previous paper that the vapour of metallic sodium is an ideal substance for investigating the effect of a strong absorption band on the magnetic rotation of the plane of polarisation. The preliminary work was not very satisfactory, as the method employed did not admit of very accurate determinations of the wave-lengths. Improvements in the methods of observation and design of the apparatus have been accompanied by an increase in accuracy, and accurate readings have been obtained for as many as nine different values of λ between D_1 and D_2. Rotations as great is 1440° (four complete revolutions) have actually been observed, and this with a 10 cm. column of not very dense vapour in a field of 2000 C.G.S. units. In the present paper the magneto-optics of the vapour for light travelling along the lines of force are discussed. The sodium was heated in a tube of thin steel, the ends of which projected from the helices of the magnet. It was found that the field strength within the steel tube did not differ greatly from that obtained when glass tubes were used. A short piece of small brass tubing is brazed into one end of the steel tube, through which the steel tube is exhausted. A good vacuum is essential, all traces of rotation disappearing in hydrogen or nitrogen at atmospheric pressure. Light from an arc-lamp made parallel by a lens is passed through a Nicol's prism, the steel tube, and a second Nicol, after which it is brought to a focus upon the slit of a spectroscope by means of a second lens. In the present case, a concave grating of 14 feet radius was used instead of a spectroscope, the observations being made both visually and by means of photography. The paper then describes the phenomena which are presented when the sodium vapour is formed in the magnetic field. In the case of very dense vapours the rotation has been measured over a considerable range of wave-lengths, namely, throughout the region comprised between $\lambda=5840$ and $\lambda=5922$. The rotation constant of D_2 was found to be about double that of D_1. Drude, in his "Lehrbuch der Optik," has given two formulæ for the magnetic rotatory dispersion, the first of which, developed from the hypothesis of molecular currents, calls for an anomalous effect on crossing the band, and does not apply to sodium vapour. The second, developed from the Hall-effect hypothesis, predicts rotations of similar sign and equal magnitude for wave-lengths symmetrically situated in the spectrum, with respect to the centre of the absorption-band. It seems likely that the molecular currents play some part, and that the formula built up on the hypothesis of the Hall-effect is incomplete. However, the latter formula represents the rotation outside of the D-lines with great accuracy, while between the lines it gives in some cases a curve which is elevated somewhat above the experimental curve. The paper concludes with an account of the bright-line spectrum produced by magnetic rotation which presents itself when the Nicol's prisms of the apparatus are crossed. The spectrum, which at first could only be seen with difficulty, was finally obtained of such brilliancy that it could be photographed with a 14-feet concave grating. A good vacuum was found to be an essential condition, the presence of inert gases causing a faintness of the lines.—The fluorescence of sodium vapour: Prof. R. W. **Wood.** The fluorescence of sodium vapour has been investigated by allowing light of various wave-lengths to illuminate the vapour, and then studying the light emitted with a spectroscope. Approximately homogeneous light of any desired wave-length is obtained by means of a monochromatic illuminator. Some sodium is placed in a horizontal steel tube fitted with steel ends, in one of which is a circular aperture bored just above the centre. The tube is heated and the vapour rises until it reaches the hole. The light from the monochromatic illuminator passes through the hole and falls upon the vapour. The fluorescent light is then observed by means of a spectroscope either visually or by photography. It is essential that the incident light should not traverse an appreciable amount of the vapour, or the fluorescent effects are masked by those of absorption. The bright lines of the fluorescent spectrum are by no means the exact complement of the absorption spectrum. Very remarkable effects have been observed when the vapour is illuminated with a *very* narrow band of approximately homogeneous light, the lines in the fluorescent spectrum changing their position and appearing to dance about with the slightest change in the wave-length of the exciting light. The motion is of course only an illusion, lines disappearing and others re-appearing, like the sparks of a spinthariscope. Stokes's law is violated in a most flagrant manner, bright lines coming out on both sides of the excited region. The behaviour of the spectrum indicates that we are dealing with a number of groups of electrons, each group containing a large number of vibrators. The excitation of one of these vibrators sets the whole group going, but does not start disturbances in the other groups.

EDINBURGH.

Royal Society, June 19.—Dr R. H. Traquair in the chair.—A comparative study of the dominant phanerogamic and higher cryptogamic flora of aquatic habit: George **West.** The paper referred to three loch areas of Scotland, namely, Loch Ness, the district between Nairn and Forres, and the Island of Lismore. In the first district the waters were peaty, in the third they were heavily charged with lime and were free of peat, while in the second district the waters were neither limey nor peaty, but were turbid and unwholesome in appearance, due to the presence of marsh gas. These characteristics influenced in a marked degree the habit of the aquatic flora, the distribution and growth of which were also dependent on the direction of the prevailing winds. Interesting details were given.—Les concrétions phosphatées de l'Agulhas Bank (Cape of Good Hope): Dr. Léon W. **Collet**; avec

une description de la glauconie qu'elles renferment, par Gabriel W. **Lee.** The work was undertaken under the direction of Sir John Murray, whose large collection of phosphatic nodules had been greatly enriched by the concretions dredged off the Cape of Good Hope by the steamer of the Department of Agriculture, and presented by Dr. Gilchrist, the Government biologist. The concretions were found beyond the 100-fathom line down to depths of 800 fathoms. Their occurrence, as already pointed out by Sir John Murray, is closely connected with the oceanographical question of the variability of temperature in certain regions. The mingling of two currents of different temperature is necessarily attended by a great mortality among the creatures living in these waters, and their dead bodies falling to the bottom produce ammonia and phosphate of lime. There can be little doubt that the glauconite and phosphates found in geological strata have been formed under similar conditions. In the material from the Agulhas Bank two kinds of nodules were found :—(1) those with Foraminifera and other calcareous organisms ; (2) those without carbonate of lime and with the glauconite grains cemented together by phosphatic matter. These implied different modes of formation. Mr. Lee recognised two kinds of glauconite in the phosphatic nodules, the occurrence in the one kind being in the form of grains with definite contours, in the other in the form of a diffused pigment.—Note on some of the magnetic properties of demagnetised and annealed iron : James **Russell.** The iron was demagnetised by one of three methods, namely, by decreasing reversals of magnetic force co-directional with the field to be afterwards applied in the study of the permeability, by decreasing reversals of a transverse force, or by annealing. The permeabilities after these processes of demagnetisation were carried out were then compared, and various interesting conclusions arrived at. One very remarkable result was that, however much the values of the permeability differed under these varied conditions, the value of the coercive force (as defined by Hopkinson) was almost exactly the same in all cases.—Certain mathematical instruments for graphically indicating the direction of refracted and reflected light rays : J. R. **Milne.** These simple devices were not only useful in demonstrating the course of reflected and refracted rays, but could also be effectively used in graphically solving problems in geometrical optics the algebraic solution of which presented insurmountable difficulties in the way of carrying out the necessary eliminations.—On the hydrodynamical theory of seiches : Prof. **Chrystal.** This paper contained the mathematical solution of problems suggested by the phenomena of seiches in lakes, and showed how the periods of the various possible seiches and the positions of the nodes were affected by the contour of the lake bottom.—On a group of linear differential equations of the second order, including Chrystal's seiche-equations as special cases : Dr. **Halm.** This formed an important sequel to the foregoing paper, giving a mode of arriving at a solution of a case in which the direct method led to a slowly converging series, ill-suited for numerical determinations.—A monograph on the general morphology of the myxinoid fishes, based on a study of myzine, part. i., the anatomy of the skeleton : Frank J. **Cole.** By controlling the dissections by charts reconstructed from serial sections, the author obtained many results of importance in working out the micro-anatomy of the skeleton. Previous descriptions have thus been much extended, and the phylogenetic origin of the myxinoid skeleton may now be shown to be much simpler than has been hitherto supposed.

July 3.—Prof. Geikie in the chair.—The plant remains in the Scottish peat mosses, part i. : Francis J. **Lewis.** The paper contained a detailed account of the botanical stratification of peat mosses in the Scottish southern uplands, the discussion being in every case based upon evidence derived from freshly cut holes or from borings. The geological horizons were determined in most cases by the fact that the mosses rested on moraines which were known to belong to one of the Glacial periods. The conclusions were in full accord with the views originally put forward by Prof. James Geikie, and demonstrated the existence of the third, fourth, and fifth periods of glaciation in Scotland, those, namely, which are distinguished as (3) the district ice sheets, (4) the mountain valley glaciers, (5) the corrie glaciers.—Dissociation of the action of the auricles and ventricles : Dr. W. T. **Ritchie.** The paper contained an account of curious cases of heart block, a subject first studied scientifically by Gaskell. The graphs of the various pulse rhythms were obtained side by side, enabling the eye at a glance to contrast them and so prove the absolute independence of the action of the auricles and ventricles.—Cape hunting dogs (*Lycaon pictus*) in the gardens of the Royal Zoological Society of Ireland : Prof. D. J. **Cunningham.** The chief interest attached to these dogs was that they had been for the first time reared in captivity. The parents had been got from Holland, and during the four years 1896 to 1900 there had been four litters, but only three of the puppies had been brought to maturity. The peculiar colouring of the adult dog with its yellow and white patches was absent in the puppy stage, but gradually appeared as the animal grew older ; also the dark band down the forehead became more marked with age. The animals were very intractable in captivity. An attempt to obtain a cross with a collie failed, the collie when introduced into the cage showing symptoms of excessive fear, while the male Lycaon paid not the least attention to her. The period of gestation in the case of the Cape hunting dog was found to be eighty days, somewhat longer than in the case of the domestic dog.—The Alcyonarians of the Scottish National Antarctic Expedition : Prof. J. A. **Thomson** and James **Ritchie.** The collection contained six new species, and specimens of three forms previously obtained by the *Challenger*. These were found in various latitudes, the furthest south specimen having been obtained in S. lat. 74°, off Coats Land. Our knowledge of the geographical distribution has been thus much extended. Of the beautiful *Umbellula durissima* the *Challenger* obtained one young specimen from the south of Yedo, while Mr. Bruce was fortunate in obtaining about a score of specimens, some of which are larger, older, and of more vigorous growth than that which Kölliker described in the *Challenger* reports.—The theory of determinants in the historical order of development up to 1852 : Dr. Thomas **Muir.**—On the action of radium bromide on the electromotive phenomena of the eyeball of the frog : Prof. **McKendrick** and Dr. W. **Colquhoun.** It has been known since 1871 that when the fresh excised eye of a frog is connected by unpolarisable electrodes with a sensitive galvanometer an electric current may be detected, and that definite variations take place in that current when the retina is exposed to the action of light. It is also well known that salts of radium are luminous in the dark, and that when a tube containing radium is pressed against the closed lid of the eyeball a luminous effect is produced. It was of interest to ascertain whether this luminosity was due to the radium causing fluorescence of any of the structures of the eyeball, or whether it was due to the direct action of the radium emanations on the retina itself. The radium employed was kindly lent by Dr. Hardy, of Cambridge. The conclusions were as follows :—(1) The light emanating from radium bromide affects the electromotive phenomena of the living retina of the frog in a manner similar to that of light, although to a considerably less degree ; (2) its action is not due to fluorescence of any of the structures of the eyeball, but to direct action on the retina ; (3) the retina of the frog will respond to emanations of radium passing through cardboard, blackened paper, thin glass, and aluminium foil, emanations which, when allowed to fall on the human eye in a perfectly dark chamber, do not give rise to a luminous sensation ; (4) the frog's eye is sensitive to the feeble light emitted from the surface of fluorescible minerals and fluids rendered fluorescent by radium ; (5) the β rays are responsible for most of the effects observed, but after they have been largely excluded by thick glass a slight effect still persists, due presumably to the γ rays ; (6) monochromatic light employed in a photographic chamber may still affect the electromotive phenomena of the living retina of the frog ; (7) no satisfactory evidence could be obtained of the action of the ultra-violet rays of a lamp filtered through a Wood's screen. The slight movement of the galvanometer observed with light "off" might possibly be ac-

counted for by mechanical disturbance of the apparatus. As already pointed out by Prof. Gotch, there is great advantage in "adapting" the eye to darkness or to coloured light for three or four days.

DUBLIN.

Royal Dublin Society, June 20.—Prof. W. Noel Hartley, F.R.S., in the chair.—On the supply of water to leaves on a dead branch: Prof. H. H. **Dixon.** The fading of leaves on a branch killed by the application of heat is shown experimentally to be due in many cases at least to the introduction into the transpiration current of substances which cause a loss of turgescence of the leaf cells; consequently this fading does not prove that the water supply in these cases is inadequate, but rather that it is contaminated. A diminution, however, of the water supply may be caused by the high temperature, if this latter determines the rupture of the water columns of the tensile transpiration current or brings about the exudation of clogging substances into the conducting tracts from the dying cells. The conclusion, based on the withering of leaves on a killed branch, that the intervention of living cells is necessary to the elevation of the sap is thus rendered superfluous.—On the diagnosis of the eye by means of pinhole-vision: Prof. W. F. **Barrett,** F.R.S. The self-examination of the eye by looking through a pinhole in an opaque screen was termed *entoptic diagnosis* by Listing, who submitted this method to careful examination more than fifty years ago. The author was independently led to a similar discovery by noticing fixed shadows on his own retina when a bright spot of light was looked at. These shadows proved to be due to cataract, and led the author to the construction of an instrument which he calls an *entoptoscope,* whereby the patient can easily draw the exact extent of the obscuration in either eye. By means of two closely adjacent pinholes in a revolving diaphragm in the eye-piece and a transparent scale, the actual magnitude and position of the opacity in the eyeball can be accurately determined.—On secondary radiation (part iii.): Prof. J. A. **McClelland.** A continuation of the author's researches.

PARIS.

Academy of Sciences, July 10.—M. Troost in the chair.—On a calculation of the elastic resistance offered by a tube without longitudinal tension to inflation by a contained liquid column: J. **Boussinesq.**—On some experiments relating to the radio-activity induced by uranium: Henri **Becquerel.** This paper contains a study of the properties of the body formerly discovered by precipitation from the mixed barium and uranium chlorides by sulphuric acid, and since probably identified with Crookes's uranium X. It shows a remarkable stability of activity at very high temperatures.—On the treatment of trypanosomatous disease (surra, mbori) by arsenious acid and trypan red: A. **Laveran.** Extending his investigations on this method of treatment, the author has definitely cured the disease in dogs, animals in which it has always previously proved fatal. No trace of infection could even be found in the blood of the cured dogs.—On the treatment of bone fractures by movement: J. **Lucas-Championnière.** This new method follows a law which surgery hitherto has ignored, that, in spite of their rigidity, bones, like other tissues, require movement to ensure the vitality necessary for recuperation. The practice which the author follows is a peculiar form of massage, and not only conduces to the formation of the hard tissue, but is also favourable to the quick reparation of other neighbouring organs, such as muscles and tendons, involved in the fracture.—On the use of rockets against hail: E. **Vidal.** This paper explains how they are effectual in those cases where the storm centre is at a low altitude.—Researches on algebraic integrals in the motion of a solid heavy body about a fixed point: Édouard **Husson.**—On a new preparation of rubidium and cæsium: L. **Hackspill.** The author finds that these metals can be obtained by a method similar to that for obtaining potassium or sodium, viz. by reduction at a dull red heat of the alkaline chlorides with calcium. The resulting metal does not even attack glass.—A comparison of properties, tests, and classification of ternary steels: Léon **Guillet.**—On the molecular transformations of hydrated ferric sulphate: A. **Recoura.** If a concentrated solution of ferric sulphate be allowed to stand for some days a deposit forms, which rapidly grows until the liquid becomes practically solid. This occurs through the formation of a mixture of basic sulphate and free acid.—On dextro-dilactide: E. **Jungfleisch** and M. **Godchot.**—On the hydrogenation of the ketoximes. A synthesis of new amines: A. **Mailhe.** Among others, acetoxime by reduction with finely divided nickel gives a mixture of isopropylamine and di-isopropylamine.—On the synthesis of a new leucine: L. **Bouveault** and René **Locquin.** This body is probably one of the four possible amino-butyl-acetic acids.—On sparteine, and the symmetric character of the molecule: Charles **Moureu** and Amand **Valeur.**—On a sulphate of chromium which resists the action of reagents: Albert **Colson.**—On the figures formed by pressure or percussion on plastic crystalline metals: F. **Osmond** and G. **Cartaud.** These consist of groups of lines, curved on iron, straight on other plastic metals of the cubic system.—On some points in the morphology of the schizopods: H. **Coutière.**—On the segmentary organs at the moment of sexual maturity among the Hésionians and the Lycoridians: Louis **Fage.**—On the retraction of the mouth in the Chetopods: C. **Viguier.**—On an estimation of the red corpuscles in human blood made at the summit of Mont Blanc: Raoul **Bayeux.** After giving a table of results, the author concludes that a rapid increase in the number of red corpuscles takes place with increasing altitude. This number soon falls off with some rapidity, but remains abnormally high even some time after a return to the lowest point.—On intestinal poisons (their nature, and precautions to be taken against them): MM. **Charrin** and **Le Play.**—On the preparation and properties of protoplasmic extracts from blood corpuscles: Auguste **Lumière,** L. **Lumière,** and J. **Chevrotier.**—On the activity brought about in pure pancreatic juice by the combined influence of colloids and electrolytes: Larguier **des Bancels.** An inactive pancreatic juice becomes under these conditions capable of digesting albumin.—On the decomposition of albuminoids by Actinomyces: E. **Macé.**—On the Tertiary beds of Ouennougha and Medjana (Algeria): E. **Ficheur** and J. **Savornin.**

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THURSDAY, JULY 27, 1905.

THE AGENTS OF EARTH SCULPTURE.

Geology—Processes and their Results. By Thomas C. Chamberlin and Rollin D. Salisbury. Pp. xix+654. (London: John Murray, 1905.) Price 21s. net.

It is appropriate that this work is written by experienced members of the United States Geological Survey who are likewise heads respectively of the departments of geology and geography in the University of Chicago. The main portion of the volume treats of the earth's physical features and their origin, and thus illustrates the forces and processes which belong to the borderland between past and present in which geologists and geographers are alike concerned. No aspect of geology appeals to a larger circle of interested students and general readers. The preface being dated from the University of Chicago, it may be inferred that the book is published simultaneously in the United States. It is printed in bold type on thick paper, and with such abundant illustrations that it is a veritable picture-book. There are 24 plates and 471 text illustrations; the latter are not listed, however, in the table of contents. In the eyes of a book-lover the appearance of the book is somewhat marred by its being cut down rather too closely; but as the student will pay more attention to the subject-matter he may at once be assured that it is a sound, vigorously written work, abounding in original information and suggestions, and abreast of the ever-expanding knowledge to which American geologists have so largely contributed. Nor is there wanting due acknowledgment of many facts and illustrations drawn from published sources.

In their preliminary remarks the authors make a noteworthy use of statistics. Thus we read that "The total mass of the atmosphere is estimated at five quadrillion tons," that "About 1300 quadrillion tons of water lie upon the surface of the solid earth," and that the volume of the stony portion is about 260,000 million cubic miles. These estimates, incomprehensible by themselves, are rendered useful by comparisons, and the relative mass and extent of atmosphere, hydrosphere, and lithosphere are thereby brought clearly before the reader. It is pointed out that the oceanic depressions rather than the continental masses are the master phenomena of the earth's surface, and that if the surface were graded to a common level by cutting away the land and dumping the matter in the abysmal basins, the average plane would lie somewhere near 9000 feet below sea-level.

In dealing with the atmosphere as a geological agent, dust and blown sand, wind-ripples and wind-erosion, the influence of the colour of rocks on their daily range of temperature, the creep of soils and subsoils, and even the effects of lightning receive attention.

Rain and river erosion are discussed from hypothetical, and more fully from actual, points of view. Various stages in the history of streams and valleys are illustrated, and their distinguishing features in youth, in mature and in old age are described. It is pointed out that the base-level of erosion and sea-level are by no means synonymous, as rivers often erode below sea-level. The development of rivers under different structural conditions is explained, and attention is directed even to the possible influence of the rotation of the earth on the erosive action of streams. The beheading of one stream by another is treated as "piracy," and both "foreign" and "domestic piracy" are explained, the latter phrase being applied to cutting off an ox-bow in a meandering stream. Other terms of a somewhat homely nature are used, such as "scour and fill," in illustration of the fact that a stream in flood degrades its channel and aggrades (builds up) its plain.

There is a notable chapter on ground-water, a subject of great scientific interest as well as practical importance. The movements of ground-water include the fluctuations in its upper surface or "water table," and those dependent on the outflow of water in springs or on its abstraction by pumping, influenced as the movements also are by geological structure.

The work of snow and ice, of continental and alpine glaciers, is treated in an attractive and luminous style. The way of "getting load," the englacial and superglacial drift, the transfers of load from basal to higher portions of the ice, and the movements accompanied by shearing-planes and thrusts, are duly described.

"Hanging valleys" receive attention, and it is remarked that those developed by stream-erosion are not common, except in cases of the recession of a waterfall past the mouth of a tributary. The features are characteristic of regions recently glaciated, where, as in the western mountains of North America and elsewhere, a main valley has been deepened by glacial action below the level of tributary streams.

The work of the ocean is fully discussed and illustrated. The cutting of cliffs in different materials. the formation of arches, stacks, and beaches, and rill-marks on sands that simulate sea-weeds, and other subjects large and small come under consideration. The later chapters are occupied by "the origin and descent of rocks"; minerals and rocks are described, and some account is given of the new, and by no means popular, American petrological classification and nomenclature. Various structural features, cross-bedding, nodules, joints, folds, &c., as well as deformations, volcanic action, and other topics, are illustrated.

The geological functions of life are then dealt with. The consumption and restoration of carbon dioxide and the consequent influence on climate are discussed. The agency of organisms in the disintegration of rocks, and the protection they afford against erosion are pointed out. Attention is also directed to the influence of land vegetation on the character of sediments, due in the first place to the decomposition of different rocks and the formation of soils—materials which may be carried out to sea. On the other hand, "if the surface be bare of vegetation, the crystalline rocks are usually *disaggregated* before they are de-

composed." The bearing of these facts on the question of vegetal coverings in the earlier periods is briefly discussed. Observations on organic rocks, and on the distribution and development of the fauna and flora, lead up to the subject of historical geology, which the authors propose to deal with in another volume. H. B. W.

MACHINERY FOR HANDLING RAW MATERIAL.

The Mechanical Handling of Material. By G. F. Zimmer. Pp. xii+521; illustrated. (London: Crosby Lockwood and Son, 1905.) Price 25s. net.

IN the preface Mr. Zimmer says that he has been for twenty years professionally engaged in this branch of engineering, and he was recently induced to put together in the form of a treatise—the first in English on the subject—the mass of notes he had gradually accumulated. The importance of the subject is emphasised in the introduction by a few suggestive figures as to the amount of raw materials which has to be dealt with annually, and it may be noted that the wages of an ordinary labourer are equivalent to the interest on 1000*l.* of capital.

The question of the continuous handling of material is treated in the first section of the book; special prominence is given to elevators for the conveyance of corn and flour, and to the important problem of the supply of coke, ore, &c., to the top of blast furnaces; illustrations are given of the latest American furnace hoists. The system of band conveying, due to the inventive skill of Mr. Lyster, engineer to the Liverpool Docks, and the automatic throw-off carriage for such conveyors, also due to Mr. Lyster, are described in detail. Vibrating trough conveyors—the latest type of such machinery, and especially useful with any material which would deteriorate in rough treatment—are then dealt with. Tightening gears, power required, and speed of travel in the different types of convevors are discussed in a special chapter, thus facilitating reference and comparison. The various types of pneumatic elevators, including the successful Duckham system for loading grain which has been extensively used, are next treated. This section of the book is concluded by a series of descriptions, in every case with illustrations, of conveyors which have been designed for special purposes, such as timber conveyors, hot coke conveyors for gas works, and casting machines for use with large blast furnaces.

The intermittent handling of material, mainly by endless chains and ropes, including the many systems of aërial cable-ways, forms the second section of Mr. Zimmer's book. One of the examples selected to illustrate the use of aërial ropeways is that used during the building of the new Beachy Head Lighthouse, and full credit is given to Messrs. Bullivant for the ingenious way in which the many practical difficulties were overcome. We may mention that it is to this system of aërial ropeway that the rapid completion of that remarkable bridge which will convev the Rhodesian railways over the great gorge of the Zambesi, almost within a stone's throw of the famous falls, is due; it not only facilitated the erection of the bridge, but it also enabled the permanent way and rolling stock for the northern continuation of the railway line to be transported to the north bank of the gorge long before the bridge itself was completed. The interesting question of the coaling of ships at sea, a subject of special interest in view of the recent voyage of the famous Baltic Fleet to the East, forms the conclusion to this section.

The third section of the book is devoted to unloading and loading appliances. The discharging of vessels in docks, and the discharging of railway trucks—work requiring so much labour—have been fertile subjects of invention, and a large number of systems of grab-elevators and self-emptying trucks are described. In view of the enormous weight of coal annually shipped at the various coal shipping centres, no branch of the mechanical handling of material has received more attention than that of coal tips for loading colliers, and the chapter which treats of coal tips is a most complete and valuable one. In the last section of the book a number of miscellaneous devices, which the author has found it impossible to group under any of the previous divisions, are described, such as the automatic weighing of material, the coaling of railway engines, &c. Large flour and silo warehouses form an essential feature in the mechanical handling of raw materials such as grain and seed, and a couple of chapters, illustrated with the help of a number of plates, are given up to a detailed account of the main features of their design.

The book will be indispensable to all engineering firms, consulting engineers, and architects who have to deal with this important question either in the way of designing machinery or of erecting warehouses, and it is, though highly technical, a book which will appeal to the general reader anxious to obtain some slight knowledge of the latest advance in the mechanical handling and transport of the immense quantities of raw materials used daily in our industrial life. T. H. B.

THE BUTTERFLIES OF INDIA.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by W. T. Blanford. *Butterflies.* Vol. i. By Lieut.-Colonel C. T. Bingham. Pp. xxii+511; Figs. 94; Plates 10. (London: Taylor and Francis, 1905.) Price 20s.

NINETY years ago, when Kirby and Spence published the first volume of their "Introduction to Entomology," they considered it necessary to devote a whole letter, filling many pages, to refuting popular prejudices against the frivolity and uselessness of the study of entomology; and, no doubt, at that period butterfly-collecting was looked upon as a very silly, childish pursuit; while less than 200 years before, in the time of Charles II., a serious attempt was made to set aside the will of a certain Lady Glanvil, on the ground of insanity, as shown by her fondness for collecting butterflies.

Now, however, instead of butterfly-collecting being ridiculed, it has become almost necessary to discourage it in England in order to prevent the total extermination of all our rare and local species, while abroad it is pursued with enthusiasm by travellers and colonials, some of them belonging to the highest social circles. Again, during the last fifty years, so much light has been thrown on various scientific problems by the study of butterflies that eminent professors are ready to devote a great portion of their lives to such investigations.

Of late years, many Indian officers and civilians have taken up the collection and study of the butterflies of our Indian Empire, which are probably better known at the present time than those of any other part of the world outside Europe, except North America and South Africa. But there exists no complete work on the subject suitable for the use of students. Mr. F. Moore's great works on the butterflies of Ceylon and India are very bulky and costly, and the latter is still in progress, while the regretted death of L. de Nicéville left the work commenced by himself and Col. Marshall, and subsequently carried on by de Nicéville only, complete only as regards the earlier families. Lieut.-Colonel Bingham, a retired Indian officer, who has collected insects assiduously in many parts of India, Burma, &c., and who has already published two volumes on Hymenoptera in the present series, "The Fauna of British India," has been wisely chosen to supply the existing want of a manual of Indian butterflies, and with his previous practical experience behind him, and with sufficient leisure, and access to the collections and library of the Natural History Museum at South Kensington at his disposal, the work could not have been placed in better or more competent hands.

It is expected that three volumes will be required to deal adequately with the subject. Six families are admitted by the author, of which the first two, Nymphalidæ and Nemeobidæ, are discussed in the first volume. The arrangement of the work is similar to that which has been used in previous volumes of this series dealing with insects, which are already well known to all entomologists. The introduction, necessarily brief, contains remarks on classification, metamorphoses and structure, with text-illustrations of the larva and pupa of Vanessa, the head and body of Argynnis and Charaxes, and a very useful selection of figures of labial palpi, antennæ, neuration of wings, and legs. It is worthy of special remark that the author expressly discards the term "species" as liable to mislead, and uses "form" instead, as less objectionable.

Four hundred and seventy-nine species are described in vol. i., belonging to the Nymphalidæ (with six subfamilies, Danainæ, Satyrinæ, Acræinæ, Libytheinæ, Morphinæ, and Nymphalinæ), and Nemeobidæ (five genera only).

The text illustrations are excellent, and among the more interesting ones we may note Figs. 13 and 14, on p. 40, showing the variations in shape and markings of the forewings of seven specimens of *Euploea klugii*, Moore, and Fig. 94, on p. 501, of *Stiboges nymphidia*, Butl., showing its remarkable resemblance to a species of the well-known tropical American genus Nymphidium.

Ten full-page plates (half-figures only) are added, drawn by Mr. Horace Knight and lithographed by the three-colour process by Messrs. Hentschel, and these alone are sufficient to give some idea to outsiders of the variety and beauty of the butterflies of India. If we take the butterflies of Great Britain at 70, those of Europe at 300, and those of British India, within the limits of the present work, at 1500, we shall have a fairly accurate idea of the proportions borne to each other by these three faunas.

In outlying districts, no doubt, many species still remain to be added to the Indian butterfly fauna, but apart from this, nothing is yet known of the transformations, habits, &c., of a great proportion of the insects, which will be sufficient to occupy the attention of numerous observers for many years. The metamorphoses of each butterfly, so far as yet known, are briefly noticed by Lieut.-Colonel Bingham, but it is only occasionally that he has been able to offer his readers any information of this description.

THE STATE AND AGRICULTURE.

The State and Agriculture in Hungary. By Dr. Ignatius Darányi, translated by A. György. Pp. xxii+264. (London: Macmillan and Co., Ltd., 1905.) Price 5*s*. net.

THERE are two fundamentally opposite theories of the duties of a public department dealing with a great industry such as the Board of Agriculture in this country—the one that its function is to foster the industry, the other that it is simply concerned in registering the progress and administering such legislative enactments as may be necessary from time to time.

Our English public offices have all grown up on the latter model, and the Board of Agriculture, which is always being abused for not doing this or that to improve the position of farmers, might legitimately answer that it was never designed to offer any such help to the agriculturist. Of course, the official apologists of the Board cannot put forward such a view nakedly; their plan is rather to divert the unreasonable attack by a show of activity.

To take a concrete case; the Board of Agriculture endeavours to eradicate swine fever—that it recognises as a proper function, true police work for agriculture —but supposing it should be urged to do something to improve the breed of pigs kept in England by introducing new breeds or by distributing boars of the right type in the backward districts, it would probably meet the demand by issuing a leaflet on "points to be aimed at in pig-breeding." The English method is cheap; it is also supposed to be bracing; and the English farmer, being subjected to the State-aided and bounty-fed competition of all other agricultural countries in the only open market, his own, is supposed to be in special need of a bracing *régime*.

So when people ask why the Board of Agriculture does not educate like France, or investigate like

Germany, or introduce new crops and new industries like the United States, or organise its workers like Hungary, the Board has one sufficient and final answer in the fact that such has never been the English theory of the function of a public office.

In the book before us we have an account of the policy of a man who took a different point of view, and created, perhaps, the most paternal ministry of agriculture in the world. Dr. Ignatius Darányi was Minister of Agriculture for seven years (1896–1903) in Hungary, and during his tenure of office he built up an extraordinary system of agricultural education, investigation, and organisation in Hungary. It would be impossible in the limits at our disposal to discuss either the means adopted or the results that have accrued; roughly speaking, Dr. Darányi's method in any industry was to make a start with a State-owned farm or garden, forest or mill, as the case might be. Here proceeded the investigations necessary to establish the conditions requisite for success, and from this centre issued the teachers who carried the new methods to the cultivators. The State then stepped in again, sometimes to lend the cultivator the money necessary for the fresh start, or to organise a co-operative society to enable him to realise the full advantage of the newer methods. Thus, by leaps and bounds, the whole character and quality of Hungarian agriculture has been changed. The reader will find the process set out fully with a wealth of statistical detail in Dr. Darányi's book, which takes the form of a kind of valedictory report on quitting office. It has been excellently translated by Mr. György, who, knowing so well the conditions prevailing in England, adds a preface discussing the value and limits of State interference in such matters. It is a wonderful record; to the English reader, particularly if he be a farmer, it seems difficult to believe that so much can be done for the industry, and also that the distance of a few hundred miles should render impossible in this country methods that have proved so practicable and so fruitful for the Hungarian agriculturist.

OUR BOOK SHELF.

The Treatment of Diseases of the Eye. By Dr. Victor Hanke. Translated by J. Herbert Parsons, F.R.C.S., and George Coats, M.D., F.R.C.S. Pp. vi+222. (London: Hodder and Stoughton, 1905.) Price 3*s.* 6*d.* net.

Dr. Victor Hanke, the writer of this little book, is principal assistant to Prof. Fuchs in Vienna, and the methods of this famous clinique are those which are here given to a wider public. It naturally follows that it is characterised throughout by a practical sanity which has been sadly lacking in some books on similar subjects which have recently been thought worthy of translation. The author has no special hobby-horse on which to ride to mental destruction. His treatment throughout is practical, scientific in the best sense of the word, what we may call for lack of a more fitting adjective, commonsensical. There is no rash advocacy of new and untried methods of treatment simply because of their novelty. Consequently, it is a book which can be thoroughly recommended to all practitioners of the art of medicine. Reliance on it will not lead to disappointment, for the methods advocated are thoroughly modern and sound.

A careful reading reveals practically no ground for adverse criticism, and many points for active commendation. The warning against the indiscriminate use of cocaine is one that should be unnecessary to any practising ophthalmic surgeon, and yet we have only recently seen prescriptions for lotions and drops given to patients for frequent use containing cocaine. "The immoderate use of cocaine . . . is not only unnecessary but actually harmful to the corneal epithelium"; and again, "Cocaine should in general not be used, for on the one hand its action is only transitory, while on the other it has an injurious influence on the corneal epithelium; moreover the dilatation which follows the temporary contraction of the vessels is harmful."

It would be easy to point out many places in which good results can be obtained by methods of treatment other than those recommended, but as the book does not in any way pretend to be exhaustive, and as the methods given are thoroughly sound, it would be hypercritical to do so. We doubt, however, the advisability of the use of adrenalin in severe inflammatory glaucoma, even if only given to facilitate the operation. Macallan, in a paper in the Ophthalmic Hospital reports some two or three years ago, pointed out the dangers of this drug in glaucoma, and its tendency to set up the hæmorrhagic form.

The chapter on the various forms of inflammation of the cornea and their treatment is quite the most valuable in the book, and generally the earlier chapters dealing with the external diseases of the eye are fuller than the later chapters. The reason of this is that the author does not pretend to give descriptions of operations where only "considerable skill and experience can command success," and in diseases of the deeper parts of the eye the advice of the ophthalmic surgeon is more likely to be called for, and this book is not intended for him. In conclusion, we can only reiterate what we have already stated, that students of medicine will find this a thoroughly safe guide in the treatment of diseases of the eye.

Die Stellung Gassendis zu Deskartes. By Dr. Hermann Schneider. Pp. 67. (Leipzig: Dürr'sche Buchhandlung, 1904.) Price 1.50 marks.

Gassendi and Descartes were contemporaries and fellow-countrymen, but the relation between them is mainly one of contrast. Gassendi was of peasant origin, a writer encyclopædic in his range, an *Epicurus redivivus* with all Epicurus's distrust of mathematics and all his belief in a material soul, a sceptic who was yet content to remain in the ranks of the Catholic priesthood, his face ever turned to the past whether in philosophy or religion. On the other side there is Descartes, a noble by birth, a student principally of the human understanding, something of a Platonist, with the Platonist's reverence for mathematics and numbers, a dualist who fixed a great gulf between mind and body and between man and the lower animals, an uncompromising doubter of everything but his own doubt and all that is implied by the capacity to doubt, the exponent of *cogito, ergo sum*—in a word, the representative of the distinctively modern tendencies, which mean in religion Protestantism, in science mathematical physics, in philosophy Kantianism new and old. Only in so far as modern thought inclines to atomism and materialism—and how much that is the author points out in his closing paragraph—do we find that its sympathies lie with Gassendi rather than with Descartes.

These contrasts, extended into a detailed discussion of some of the writers' most important works and particularly of their views on psychology, physics, and

ethics, are well brought out by this author. His book may be heartily recommended to students of the period described.

A Text-book of Physics, Heat. By Prof. J. H. Poynting, Sc.D., F.R.S., and Prof. J. J. Thomson, M.A., F.R.S. Pp. xvi+354. (London: C. Griffin and Co., Ltd., 1904.) Price 15s.

THE third volume of this well known text-book more than sustains the standard set by its predecessors. The volumes on sound and properties of matter have already appeared. The volumes on light and on electricity and magnetism we hope may follow at a somewhat shorter interval than has intervened between the first three volumes of the series. It is hardly necessary to say that the work is well up to date, and extremely clear and exact throughout, and that it is as complete as it would be possible to make such a text-book within the limits which the authors have laid down for the scope of their work. Among the more original features which should be valuable to the student as filling gaps which are noticeable in similar text-books, we observe that a useful chapter is included on the subject of circulation and convection, with illustrations from meteorology and ventilation. The treatment of the important subject of radiation, especially in relation to temperature and thermodynamics, is unusually complete and clear, and presents in a simple, connected form a number of most important results which the student would have difficulty in finding elsewhere. The experimental spirit is maintained throughout the work in such a manner that the student will feel that he is learning from a practical master of the subject, and will unconsciously imbibe something of the attitude of mind of the original investigator. H. L. C.

The Oxford Atlas of the British Colonies. Part i. British Africa. Seventeen maps. (Oxford Geographical Institute: William Stanford and Co., Ltd., n.d.) Price 2s. 6d. net.

THE first thirteen plates consist of coloured maps, and the remaining four are outlines intended for use as "test" maps or for other class purposes. The first map shows a hemisphere in which Cape Colony occupies the centre, and it is possible from it to see at once the relation of South Africa to the other continents. Map ii. is a political map of the world drawn in accordance with Mollweides's equal area projection, and the student will notice at a glance the apparent distortion in shape, though the relative sizes of land areas in different parts of the map are correctly shown. In addition to meteorological charts, the atlas includes physical and political maps of Africa, and maps of Cape Colony, Natal and Zululand, the Transvaal and Orange River Colony, Rhodesia, and of West, East, and Central Africa.

High Temperature Measurements. By H. Le Chatelier and O. Boudouard. Authorised translation and additions by Dr. G. K. Burgess. Second edition. Pp. xv+341. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 12s. 6d. net.

IN preparing the present edition it was found necessary to make a large number of additions, and the book now gives a useful summary of what is known about pyrometry. The advances in optical pyrometry during the last few years are recognised by the authors, and a useful chapter on the laws of radiation has been inserted. A number of pyrometers are described, but the discussion of the principles involved is in general more adequate than the description of instruments. No mention is made of some of the best of these in use in this country.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Comparison between Two Theories of Radiation.

ON two occasions (NATURE, May 18 and July 13) Lord Rayleigh has asked for a critical comparison of two theories of radiation, the one developed by Prof. Planck (*Drude's Annalen,* i. p. 69, and iv. p. 553) and the other by myself, following the dynamical principles laid down by Maxwell and Lord Rayleigh. It is with the greatest hesitation that I venture to express my disagreement with some points in the work of so distinguished a physicist as Prof. Planck, but Lord Rayleigh's second demand for a comparison of the two methods leads me to offer the following remarks, which would not otherwise have been published, on the theory of Prof. Planck.

Early in his second paper, Planck introduces the conception of the "entropy of a single resonator" S. There are supposed to be N resonators having a total entropy $S_N = NS$, and S_N is supposed to be given by $S_N = k \log W +$ constant, where W is the "probability" that the N resonators shall be as they are. Without discussing the legitimacy of assigning entropy to a single resonator, we may at present suppose S defined by $S = k/N \log W +$ cons.

The function W, as at present defined, seems to me to have no meaning. Planck (in common, I know, with many other physicists) speaks of the "probability" of an event, without specifying the basis according to which the probability is measured. This conception of probability seems to me an inexact conception, and as such to have no place in mathematical analysis. For instance, a mathematician has no right, *quâ* mathematician, to speak of the probability that a tree shall be between six and seven feet in height unless he at the same time specifies from what trees the tree in question is to be selected, and how. If this is not so, may I ask, "What *is* the probability that a tree shall be between six and seven feet high?"

When Prof. Planck calculates the probability function W, he in effect assumes that *a priori* equal small ranges of energy are equally probable. Thus he tacitly introduces as the basis of his probability calculations an ensemble of systems of resonators such that the number of systems in which the energy of any given resonator lies between E and $E+dE$ is proportional simply to dE. This, of course, he has a right to do, only he must continue to measure probability according to this same basis.

The systems of resonators are in motion, their motion being governed by the laws of dynamics. Will they, as the motion progresses, retain the statistical property which has been the cause of their introduction, namely, that the number of systems in which the energy of any given resonator lies between E and $E+dE$ is proportional simply to dE? It is easily found, by the method explained in my "Dynamical Theory of Gases" (§ 211), that in general they will not; the probability function W is not simply a function of the coordinates of the system. Prof. Planck's position is as though he had attempted to calculate the probability that a tree should be between six and seven feet high, taking as his basis of calculation an enclosure of growing trees, and assuming the probability to be a function only of the quantities six and seven feet. His ensemble of systems has not yet reached a statistical "steady state."

Prof. Planck supposes his function S to possess the property of the entropy function, so that $1/T = dS/dU$, where T is the temperature. Combining this with Planck's calculation of S, we find

$$1/T = k/\epsilon \log (1+\epsilon/U) \quad . \quad . \quad . \quad . \quad (1)$$

Here ϵ is a small quantity, a sort of indivisible atom of energy, introduced to simplify the calculations. We may legitimately remove this artificial quantity by passing to the limit in which $\epsilon = 0$. In this way we obtain

$$1/T = k/U \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Thus the mean energy of each resonator, according to this equation, is the same multiple of the temperature, no

matter how many degrees of freedom the resonator possesses, or what the form of its potential energy. Indeed, according to this argument, equation (2) is proved for any dynamical system, *e.g.* the molecules of a gas.

It is, however, known that equation (2), with Planck's meaning of k, is true if, and only if, the energy of each dynamical system is expressible as the sum of two squares. It can, indeed, be shown directly that this latter condition is exactly the condition that Prof. Planck's assumed basis of probability calculations shall be a legitimate basis, *i.e.* shall be independent of the time. Happily, this condition of the energy being a sum of two squares may be supposed to be satisfied by Planck's resonators, so that we may regard equation (1) as true for such resonators. The equation has, however, no physical meaning, owing to the presence of the arbitrary small quantity ϵ, and can acquire a physical meaning only by putting $\epsilon=0$. It then leads merely to equation (2), which can be obtained much more readily from the theorem of equipartition.

Taking $\mathfrak{u}d\nu$ to be the law of radiation, where ν is the reciprocal of the period of vibration, Planck introduces from his first paper the equation

$$\mathfrak{u}=(8\pi\nu^2/c^3)U \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

which in combination with equation (2) would lead to the law of radiation,

$$(8\pi k/c^3)T\nu^2 d\nu \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and this, on replacing ν by c/λ, becomes

$$8\pi kT\lambda^{-4}d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which agrees with my own result. Planck arrives at equation (3) by the help of his assumption of "näturliche Strahlung," but I believe it will be found that this "assumption" is capable of immediate proof by the methods of statistical mechanics. Except for this, and the other differences already stated, the way in which expression (5) has been reached in the present letter is identical, as regards underlying physical conceptions, with the way in which it has been obtained by Lord Rayleigh and myself.

Planck does not reach expression (5) at all, as he does not pass from equation (1) to equation (2). Instead of putting $\epsilon=0$, he puts $\epsilon=h\nu$, where h is a constant, and this leads at once to his well known law of radiation. It will now be clear why Planck's formula reduces to my own when $\lambda=\infty$. For taking $\lambda=\infty$ is the same thing as taking $\nu=0$, or $\epsilon=0$.

The relation $\epsilon=h\nu$ is assumed by Planck in order that the law ultimately obtained may satisfy Wien's "displacement law," *i.e.* may be of the form

$$\nu^3/c^3 f(T/\nu)d\nu \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

This law is obtained by Wien from thermodynamical considerations on the supposition that the energy of the ether is in statistical equilibrium with that of matter at a uniform temperature. The method of statistical mechanics, however, enables us to go further and determine the form of the function $f(T/\nu)$; it is found to be $8\pi k(T/\nu)$, so that Wien's law (6) reduces to the law given by expression (4). In other words, Wien's law directs us to take $\epsilon=h\nu$, but leaves h indeterminate, whereas statistical mechanics gives us the further information that the true value of h is $h=0$. Indeed, this is sufficiently obvious from general principles. The only way of eliminating the arbitrary quantity ϵ is by taking $\epsilon=0$, and this is the same as $h=0$.

Thus it comes about that in Planck's final law

$$\frac{8\pi ch}{\lambda^5}\frac{1}{e^{ch/k\lambda T}-1}d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

the value of h is left indeterminate; on putting $h=0$, the value assigned to it by statistical mechanics, we arrive at once at the law (5).

The similarities and differences of Planck's method and my own may perhaps be best summed up by saying that the methods of both are in effect the methods of statistical mechanics and of the theorem of equipartition of energy, but that I carry the method further than Planck, since Planck stops short of the step of putting $h=0$. I venture to express the opinion that it is not legitimate to stop short at this point, as the hypotheses upon which Planck has worked lead to the relation $h=0$ as a necessary consequence.

Of course, I am aware that Planck's law is in good agreement with experiment if h is given a value different from zero, while my own law, obtained by putting $h=0$, cannot possibly agree with experiment. This does not alter my belief that the value $h=0$ is the only value which it is possible to take, my view being that the supposition that the energy of the ether is in equilibrium with that of matter is utterly erroneous in the case of ether vibrations of short wave-length under experimental conditions.

J. H. JEANS.

On the Spontaneous Action of Radium on Gelatin Media.

SINCE my communication to NATURE on the subject of the experiments in which I have been for some time past engaged, my attention has been directed to the fact that M. B. Dubois, in a speech at Lyons last November, stated that he had obtained some microscopic bodies by the action of radium salts on gelatin bouillon which had been rendered "aseptic," but in what manner it is not stated.

I write to direct attention to the fact, as also to add that M. Dubois's experiments were quite unknown to me.

Moreover, the theory that some elementary form of life, far simpler than any hitherto observed, might exist and perhaps be brought about artificially by "molecular and atomic groupings and the groupings of electrons"—in virtue of some inherent property of the atoms of such substances as radium—was pointed out in my article on the "Radio-activity of Matter" in the *Monthly Review*, November, 1903, whilst the experiments which I have been carrying out to verify this view have been for a long time known in Cambridge.

Although I did not make a speech on the subject, I demonstrated the growths to many people at the Cavendish and Pathological laboratories early in the Michaelmas Term last year.

So momentous a result as it seemed required careful confirmation, and much delay was also caused in taking the opinions of various men of science before I ventured to write to you upon the subject.

That M. Dubois's experiments have been made quite independently I do not entertain the slightest doubt.

Some critics have suggested that these forms I have observed may be identified with the curious bodies obtained by Quincke, Lehmann, Schenck, Leduc and others in recent times, and by Rainey and Crosse more than half a century ago; but I do not think, at least so far as I can at present judge, that there is sufficient reason for so classifying them together. They seem to me to have little in common except, perhaps, the scale of being to which as microscopic forms they happen to belong.

JOHN BUTLER BURKE.

The Problem of the Random Walk.

CAN any of your readers refer me to a work wherein I should find a solution of the following problem, or failing the knowledge of any existing solution provide me with an original one? I should be extremely grateful for aid in the matter.

A man starts from a point O and walks l yards in a straight line; he then turns through any angle whatever and walks another l yards in a second straight line. He repeats this process n times. I require the probability that after these n stretches he is at a distance between r and $r+\delta r$ from his starting point, O.

The problem is one of considerable interest, but I have only succeeded in obtaining an integrated solution for *two* stretches. I think, however, that a solution ought to be found, if only in the form of a series in powers of $1/n$, when n is large.

KARL PEARSON.

The Gables, East Ilsley, Berks.

British Archæology and Philistinism.

AT the end of the second week in July two contracted skeletons were found in a nurseryman's grounds near the famous British camp at Leagrave, Luton. Both were greatly contracted; one, on its right side, had both arms straight down, one under the body the other above; the other skeleton lay upon its left side, with the left hand

under the face and the right arm straight down. Both were probably female, and upon the breast of one was a fine bronze pin seven inches long with three pendant ornaments, and three discs of bronze, one plated with gold. Other bronzes of great interest were found with the second skeleton.

I do not write to describe the bones and ornaments, but to make public the conduct of the Luton authority. A most intelligent workman lives close to the site of the discovery—one Thomas Cumberland—a man who has studied the antiquities of the district for many years, and to whom antiquaries are indebted for great and freely given assistance. This man was on the spot at once, and clearly and correctly stated the age of the bones and ornaments as British or late Celtic. Notwithstanding this information, the local police insisted on an inquest, although the bones were broken to pieces and in the highest degree friable. I went to the nursery and confirmed Mr. Cumberland's determination, made drawings of the bronzes, and such an examination of the bones as circumstances would permit. The coroner refused to hold an inquest, and so had no authority to make any order, but he wrote and "suggested" that the bones should be buried in the parish churchyard. Armed with this "suggestion," the relieving officer ordered an undertaker to carry off the bones, which he did, in spite of the protest of the nurseryman, who informed him that they had been given to me and were my property. He was ordered to put the bones in coffins and bury them in the churchyard of Biscot. The undertaker took the bones to his shop at Luton. I at once applied to the relieving officer for permission to examine and measure some of the bones. I clearly explained to him the nature and importance of the discovery, and the trifling nature of the favour asked. This official replied in a curt and rude manner, and simply said, "I have no authority; you must apply to the coroner."

I repeatedly wrote to the undertaker to delay the funeral for a few days. I twice wrote to the coroner in an urgent but most respectful manner, and pointed out the importance of the discovery, which, indeed, is quite unique in this district, but all to no purpose. He said he had not given the "order" for burial, and he refused to interfere, but he wrote to the undertaker and said, "I can give no consent or authority in any way, but must leave you to carry out the arrangement which has been come to with you." I wrote letters for six days to the different persons concerned, but to no effect; they would have a funeral, and the police now actually demanded the bronzes from the owner. The property is freehold.

Well, on Wednesday last the two coffins were screwed up at Luton and taken in a hearse to Biscot churchyard, where the vicar, in the presence of a policeman, officiated. Shining breastplates were screwed on to the coffins inscribed, "Bones found at Leagrave, July 1905." Amongst the bones in the coffins were several non-human examples, a rib bone of a sheep, a piece of a rib of beef, a bone of a rabbit, and another of roebuck.

Dunstable. WORTHINGTON G. SMITH.

Graphical Solution of Cubic and Quartic Equations.

SOME years ago you published some interesting communications in regard to the graphical solution of cubic and quartic equations (vol. lxi. p. 55, vol. lxiii. pp. 515 and 609, vol. lxiv. p. 5). The solutions then given give only the real roots of the equation. I therefore take the liberty of directing attention to the following method, which gives the roots of cubic and quartic equations whether the roots are real or complex, and may be applied to equations of higher degree, with more complicated results.

A cubic equation with real coefficients may be reduced by a simple real transformation to the form

$$z^3+qz+1=0,$$

where q is real, and since the sum of the roots of this equation is zero, they may be written in the form

$$\begin{gathered}-2y\\ y+\sqrt{x}\\ y-\sqrt{x}.\end{gathered}$$

If, now, we form the symmetric functions, we have

$$\begin{gathered}3y^2+x=-q\\ 2(y^3-xy)=1.\end{gathered}$$

Hence if we draw the fixed curve

$$y^3-xy-\tfrac{1}{2}=0,$$

the coordinates of the points where it is cut by the movable parabola

$$3y^2+x+q=0$$

give the roots of the equation

$$z^3+qz+1=0,$$

i.e. if x_0 and y_0 are the coordinates of any such point, $-2y_0$ and $y_0\pm\sqrt{x_0}$ are the roots of the given equation.

In like manner a quartic equation with real coefficients may be put into the form

$$z^4+qz^2+z+s=0,$$

where q and s are real, and its roots may be put into the form

$$\begin{gathered}v\pm\sqrt{w_1}\\ -v\pm\sqrt{w_2}\end{gathered}$$

and, forming the symmetric functions, we have

$$2v^2+w_1+w_2=-q \quad \ldots \quad (1)$$
$$2v(w_1-w_2)=-1 \quad \ldots \quad (2)$$
$$v^4-(w_1+w_2)v^2+w_1w_2=s \quad \ldots \quad (3)$$

and if we put

$$\begin{gathered}4v^2=y\\ (w_1-w_2)^2=x\end{gathered}$$

we find by simple elimination

$$xy=1,\ (y+q)^2-(x+4s)=0.$$

Hence the intersections of the fixed hyperbola with the movable parabola give values for x and y from which v, w_1, and w_2 may be calculated.

If we eliminate x from the two equations last written, we have

$$y^3+2qy^2+q^2y-4sy-1=0.$$

Hence there is always at least one positive value for y, therefore a real value of v; also, since $xy=1$, a positive value for x, therefore a real value for w_1-w_2; and since from (1) w_1+w_2 is real, real values for w_1 and w_2.

H. IVAH THOMSEN.

1928 Mt. Royal Terrace, Baltimore, Md., June 7.

THE PRESENT POSITION OF THE CANCER PROBLEM.

THE term "cancer" is in common parlance indiscriminately applied to all tumours the growth of which is unlimited and generally rapid, which tend to recur after removal by operation, and particularly which reproduce their like (the secondary or metastatic growths) in parts of the body remote from the original seat of disease. Pathologically there are various forms of "cancer," or malignant disease, but there is no need to deal with these here, and it may be stated that there is no sharp line of demarcation between the so-called benign and the malignant growths; there is a series of connecting links between the two. Malignant disease is an important cause of death. According to the last published report of the Registrar General (1903), the death-rate from this cause per 1000 living was 0·87; for comparison that for pulmonary tuberculosis (consumption) may be quoted; this was 1·2.

Moreover, it is a common belief that cancer is on the increase; people remark how much more frequently it is heard of now than formerly, and apparently the statistics support this view, for the cancer death-rate, which was 0·56 in 1884, has steadily increased, and is now 0·87, as stated above. Competent statisticians, however, doubt whether the increase is real or only apparent, and partly due to more accurate diagnosis and to a greater tendency to seek medical advice. During the last two or three decades surgery has made

enormous strides, and it may be said that no region of the body is now beyond surgical interference. Many more obscure conditions, therefore, come under observation than formerly, and the vast majority of tumours removed by the surgeon are in the present day examined microscopically and their nature ascertained without doubt. In the Registrar General's Report for 1903 (p. 63), the various corrections which have to be made to obtain even an approximate corrected rate will be found. It is also to be noted that the deaths classed under "ill-defined causes," which doubtless included many cases of obscure malignant disease, have steadily fallen. Of 49,555 deaths from ill-defined causes in 1903, further inquiry showed that 439 were due to malignant disease. If these inquiries had not been made, which was formerly the case, these 439 deaths would have been omitted, and the cancer death-rate would have been correspondingly diminished. The statement is definitely made in the report of the Imperial Cancer Research Fund just issued that it is not yet possible to determine statistically whether cancer has really increased.

Cancer attacks rich and poor alike, and the manner in which it progresses to a fatal issue, unless early treated by radical operation, has caused it to be regarded with dread by all. It attacks all races of men, though the savage races seem less susceptible than the civilised, and it is met with throughout the vertebrate kingdom. There is no evidence that any form of diet or mode of life conduces to cancer-formation. The origin of cancer has for long exercised the minds of pathologists, and it is in particular the true cancers or epithelial tumours which have been the subject of most research.

The alleged causes of the origin of cancer may be divided into entogenous or intrinsic, spontaneous and anomalous changes within the organism, and ectogenous or extrinsic, derived from outside the body. Of the entogenous theories the most important are those of Thiersch and of Cohnheim. Thiersch suggested that tumour formation consisted in a loss of balance between the epithelial cells and connective tissue, whereby the former take on abnormal and undirected growth. Cohnheim referred the origin of cancer to embryonic cells which had for some unknown reason remained in an undeveloped state and become included in the tissues, and which subsequently proliferate and form the primary growth. Ectogenous theories ascribe the formation of malignant growths to the action of micro-parasites, and bacteria, yeast and other fungi, and protozoa have in turn been regarded as the causative organisms. There are, it is true, some analogies between certain microbic conditions and cancer formation, but the fact that it is a portion of the original growth conveyed by the blood and lymph to distant parts which causes the secondary growths, and that the tissues at the site of the secondary growth take no part in its formation, is quite different from what obtains in microbial affections. Attempts have been made to prove that cancer is contagious, and it is known that the disease is more prevalent in certain districts than in others, which lends some support to the parasitic theory. Auto-infection undoubtedly occurs; a cancer of the breast may infect the neighbouring arm, or of a lip the other lip, and cancer of mice can readily be inoculated into other mice, but these instances of apparent inoculation are rather of the nature of a transplantation; in the mouse it is the tissue introduced which increases and forms the malignant growth, not the tissue of the inoculated animal. Experiments by the staff of the Imperial Cancer Research Fund prove that healthy mice kept in close contact with cancerous mice never contract the disease.

The cancer of one animal is inoculable only into another animal of the same species, and human cancer, therefore, cannot be transmitted to the lower animals. All attempts to isolate a micro-parasite have proved failures, in spite of the vast amount of work done in this direction. The alleged organisms of cancer, such, for example, as certain yeast fungi, have, it is true, been found to produce tumour-like growths, but these have, on critical examination, been proved to be of the nature of granulomatous growths, and not true cancer. A point of which a good deal has been made by the supporters of the parasitic theory is that the so-called "cancer bodies," the alleged parasites, are present only in malignant growths, and not in normal or pathological tissue nor in benign tumours. But the deduction from this fact, that these bodies are therefore parasitic, has little to support it when it is considered that cancer is a unique tissue, and might obviously contain structures not found elsewhere and not necessarily parasitic. On these and other grounds the parasitic theory has of late steadily been losing ground.

The remarkable observations of Prof. Farmer and Messrs. Moore and Walker have recently thrown much light on the possible nature of the cancer process. As detailed in these columns (February 4, 1904, p. 319), it is found that in cancerous tissues many at least of the cells divide in a manner quite different from that of the somatic or body cells generally. This mode of cell-division observed in cancer is that which obtains in gametogenic or sexual reproductive tissue, and is characterised by a difference in the mode of division (transverse instead of longitudinal) and in the number (sixteen instead of thirty-two for man) of the chromatin bands or chromosomes of the nucleus, and is known as "heterotype mitosis." The division succeeding the heterotype, known as the homotype, still retains the reduced number of chromosomes, and is, therefore, sometimes termed "reduction division." Cells with reduction division do not seem to be able to regain the somatic mitosis except by fertilisation. This gametogenic-like tissue of malignant growths has been termed "gametoid." Other irregularities in division of cancerous cells also occur.

Another remarkable fact recently demonstrated by Messrs. Farmer, Moore, and Walker (NATURE, June 15, p. 164) is that in the normal reproductive tissues structures occur which are strikingly similar to the bodies ("cancer bodies") described by Ruffer, Plimmer, and others in cancerous growths, and regarded by many as parasites. These structures in the reproductive tissues are the archoplastic vesicles, and that similar structures should occur in cancerous growths (and not, be it noted, in benign tumours) on the one hand lends additional support to the idea of the gametoid nature of the cancer cells, and on the other further disproves the supposed parasitic nature of the "cancer bodies."

Is it possible from these observations to formulate a suggestion as to the nature of the cancer process? Prof. Farmer himself has stated that he and his co-workers do not profess to explain the relation between the heterotype mitosis of the gametoid cells of cancer and the life-history of cancer. It might be that the gametoid cells of the malignant growth undergo some process of fertilisation giving rise to an aberrant embryo, as it were, which by development forms the primary growth, which would thus be parasitic on the host, the secondary growths arising from a repetition of the primary event. In some plants gametogenic tissue may normally possess parasitic characteristics. There is, however, so far little evidence of fertilisation or fusion of the gametoid cells in cancer,

except that, as recently stated by Mr. Moore (*Brit. Med. Journ.*, July 8, p. 104), leucocytes or white blood cells are sometimes found within the body of the cancer cells, with which they appear to be undergoing conjugation.

Messrs, Farmer, Moore, and Walker suggest that it is possible that the malignant elements are the outcome of a phylogenetic reversion, but this would not necessarily explain the *invasiveness* of cancer. In spite of recent work, much remains to be done and to be explained before we shall be in a position clearly to understand the cancer process.

With regard to the causes which lead to the production of the gametoid cells in cancer, it has been found that in plants various stimuli will rapidly bring about heterotype mitosis, and, given the proper stimulus, probably any somatic cell may become changed into this type. The connection between chronic irritation and cancer has long been recognised, but the manner in which this factor acts to produce cancer has not been understood; but in the light of the foregoing, it may be regarded as one of the stimuli which may bring about heterotype mitosis and reduction division.

Does recent work hold out a prospect of the discovery of a curative agent for cancer? It cannot be said that our hopes in this direction have been materially increased as yet. At present almost the only hope of cure lies in early and radical operation, and it is of the greatest moment that the public should realise the importance of early treatment, and that no time should be lost in seeking advice. In superficial cancers, the X-rays and radium emanations seem to effect a cure by causing a retrogression or a necrosis of the cancer elements. Possibly the gametoid tissue of the cancer is more vulnerable than the somatic cells, and hence the former may be caused to degenerate or be destroyed without materially injuring the latter, but probably the rays cause proliferation of the connective tissue elements of the growth and interfere with its nutrition. Is it possible that the stimulus of these rays may also act like fertilisation, and causes the gametoid once more to revert to somatic cells, which then being of the nature of a foreign body are partly removed and partly remain inert?

Clowes and Gaylord (Bulletin of the Johns Hopkins Hospital, April, 1905) have observed that cancer in mice occasionally undergoes spontaneous retrogression and cure, and the same occurs, but, unfortunately, only too rarely, in human cancer. Clowes found that the blood serum of the mice in which this spontaneous cure had occurred exerted a marked curative action on other mice suffering from the disease. This suggests the possibility that work of a similar nature may eventually lead to the discovery of a means of treating human cancer, but the probability is small, for it is extremely unlikely that the serum of any animal would have the slightest effect on the human being. A spontaneously cured human being would almost certainly have to provide the serum!

R. T. HEWLETT.

BRITISH FRUIT GROWING.

THE report to the Board of Agriculture of the departmental committee appointed to consider what measures can be taken for the promotion and encouragement of fruit culture in these islands has been issued. The commissioners recommend that a special department should be formed to deal with matters relating to the fruit industry, and that this department should be subdivided into (*a*) a bureau of information; (*b*) an experimental fruit farm. The desirability of encouraging the practice of gardening in schools in the rural districts is also alluded to, and this recommendation will be generally concurred in. Legal questions connected with the tenancy and rating of land used in fruit culture are of cardinal importance, as also are those relating to the carriage of fruit by rail and to the alleged unfair treatment by the companies of the home-grower as compared with his foreign competitor. The necessity of further market accommodation is likewise insisted on.

These are all matters of importance, but they do not cover the whole of the ground. We find no reference in the report before us of the influence of the weather on the fruit crops, and yet this is a factor the potency of which outweighs all others. In the case of hardy fruits, not grown under glass, the fruit grower is in the main powerless to contend against adverse conditions. The tabulated reports from every county in the British Islands, which have been published annually for the last forty or fifty years in the *Gardeners' Chronicle,* bear ample testimony to this. Spring frosts when the trees are in blossom occur more or less every year, and when they happen to be severe, as they were this year, the results are disastrous. The reports from the cherry-growing districts of Kent this year show remarkable diversity of yield from farms in the same neighbourhood, a diversity due presumably to differences of shelter and aspect. It is difficult to see how the grower can protect himself from these adverse conditions. Experimental farms such as are recommended by the commission, and of which one is in operation at Woburn under the auspices of the Duke of Bedford, are for the most part of local value only; the lessons they teach may not be applicable in the next parish where the conditions are different.

Can nothing, therefore, be done? We should be sorry to assent to such a proposition. We believe that something could be done. But then arises the question whether, in the face of the vast importations first from the American continent, and when supplies from that quarter are exhausted, from Tasmania and Australia, any steps which the British grower could take would be of any use, commercially speaking? Again, no competition on the part of the home-grower is possible with the banana imports from the Canaries and the West Indian islands, which are assuming such vast proportions, or with the still larger importations of oranges. The case is different when what are termed soft fruits are concerned. We can hold our own with strawberries, raspberries, and currants, whilst gooseberries, especially when picked in a green condition, are among the most profitable crops that a farmer or even a cottager can grow. Spring frosts do them relatively little harm, so that a crop of some sort can generally be relied on.

From a commercial standpoint, when we talk of our home fruit-crops we mean apples or plums, and reverting to the subject of spring frosts we may well inquire whether it is not possible for our experts to raise breeds which shall be immune from injury. Our American cousins hoped for great things by the introduction of Russian apples, and some were tried here also, but the results were not encouraging, as the quality of the fruit was so indifferent that the experiment was not continued. Another lesson from the same source seems more promising. When a few years ago a "big freeze" occurred in Florida, the orange plantations suffered exceedingly. What did our friends do? Did they abuse the fickleness of their climate and take their misfortunes with the resignation of the fatalists? Not so. They set to work without loss of time to raise by means of cross-breeding a hardy variety, and they have at least made a good beginning. So, too, have our friends the

French, who by the cross-fertilisation of the hardy *Citrus triptera* and an ordinary orange have succeeded in producing a hardy variety of that fruit. Matters are as yet only in the experimental stage, but the possibility of success has been demonstrated. There is no reason whatever why our own experimentalists should not succeed with apples and plums. Earlier varieties, later varieties, hardier varieties, are all well within the range of possibility, and would be certainly forthcoming if we abandoned our present methods of chance selection and haphazard cross-breeding in favour of careful experiment and rational procedure.

Not only are experimental farms wanted for local purposes, but research stations wherein results might be obtained of universal application.

The Royal Horticultural Society has in its new garden at Wisley, presented by Sir Thomas Hanbury, a splendid opportunity before it, and it is to be hoped that it will not be backward in turning it to account. The fruit farm at Woburn, to which allusion has already been made, sets an example which might be followed and extended with advantage. Already important results with reference to the employment of manures have been obtained there which, though of a negative character, are none the less valuable.

NOTES.

THE annual meeting of the British Medical Association began at Leicester on Monday last. On Tuesday, Dr. G. Cooper Franklin, the president for the year, delivered his address, and the association's gold medal of merit was presented to Sir Constantine Holman and Dr. Andrew Clark. The Stewart prize was presented to Mr. W. H. Power, C.B.

THE British Electro-Therapeutic Society is holding a three days' meeting at Leicester this week. The following subjects are announced for consideration :—the present position of the treatment of carcinoma and sarcoma by electrical methods, neurasthenia, the X-rays in the diagnosis of pulmonary disease, and stereoscopic radiography, while a report will be given on the milliamperemeter as a measure of X-ray production.

THE forty-second annual meeting of the British Pharmaceutical Conference was opened at Brighton on Tuesday last. The organisation, it will be remembered, is distinct from the Pharmaceutical Society, and is solely concerned with "the encouragement of pharmaceutical research, and the promotion of friendly intercourse and union amongst pharmacists." The president, Mr. W. A. H. Naylor, delivered his address, and the reading and consideration of papers took place. The meeting terminates to-day.

SEVERAL earthquake disturbances are reported. According to a Central News telegram from Vienna, the seismograph at the Pola Hydrographic Station registered between 3.55 a.m. and 4.17 a.m. on Sunday last the occurrence of a severe and protracted seismic disturbance at an estimated distance of some 3720 miles, and telegrams from St. Petersburg, through Reuter's Agency, state that earthquakes occurred in Siberia at the following places and times :—at Chita at 10.25 on Sunday morning last; at Marünsk, in the Government of Tomsk, at about 9 a.m. of the same day; and at Kiakhta at 10 o'clock on the morning of Tuesday last. An earthquake is stated also to have taken place at Menstrie and Blair-Logie, and to have been felt in other parts of Scotland, shortly after midnight of Sunday last.

THE committee appointed in April last to consider the advisability or otherwise of confederating the principal London medical societies has now presented its report (one favourable to confederation), which, with certain minor alterations and additions, has been adopted. According to the *British Medical Journal*, it is suggested that the new society should be known as either the Royal Society of Medicine or the Royal Academy of Medicine, and that at first it should comprise the following sixteen sections :—(1) anæsthetic; (2) clinical; (3) dermatological; (4) diseases of children; (5) epidemiological; (6) laryngological, otological, and rhinological; (7) medical; (8) mental medicine (psychiatry); (9) neurological; (10) obstetrical and gynæcological; (11) odontological; (12) ophthalmological; (13) pathological; (14) State medicine; (15) surgical; (16) therapeutical, including general therapeutics, pharmacology, electrotherapeutics, balneology, and climatology. The hope is expressed that in the early future an anatomical and physiological section may be formed.

THE arrangements for the meeting in London of the International Statistical Institute, which is to take place from July 31 to August 4, are now practically complete. The proceedings will be opened at the Imperial Institute by the Prince of Wales, who will deliver an address. Addresses will also be given by the president of the institute, Dr. von Inama-Sternegg, and by the president of the Royal Statistical Society, the Earl of Onslow, after which the following communications will be presented and discussed :—superficie et population du monde; balance économique des nations; mortalité des grandes villes; statistique de la tuberculose; fécondité des mariages; statistique des transports internationaux; accidents du travail; international comparison of workmen's wages; recensements industriels et statistique du chômage; l'enseignement supérieur; import and export statistics; répercussion des droits de douanes; international agricultural statistics; valeurs mobilières; some subjects connected with pauperism; and discours sur l'avenir de la statistique.

PARTICULARS have been issued as to the arrangements which have been made for the autumn meeting of the Iron and Steel Institute. The meeting will be held at Sheffield from September 26 to 29, and the following papers have been offered for reading :—On the metallurgical department of Sheffield University, by Prof. J. O. Arnold; on the thermal transformation of carbon steels, by Prof. J. O. Arnold and A. McWilliam; on the nature of troostite, by Dr. C. Benedicks; on the occurrence of copper, cobalt and nickel in American pig irons, by Prof. E. D. Campbell; on pipe in steel ingots, by J. E. Fletcher; on steel for motor-car construction, by L. Guillet; on the presence of greenish-coloured markings in the fractured surface of test pieces, by Captain H. G. Howorth, R.A.; on overheated steel, by A. W. Richards and J. E. Stead, F.R.S.; on segregation in steel ingots, by B. Talbot; on a manipulator for steel bars, by D. Upton; on machinery for breaking pig iron, by C. Walton; on the influence of carbon on nickel and iron, by G. B. Waterhouse.

THE congress of the International Society of Surgery will this year be held in Brussels. The meetings will take place from Monday, September 18, to Saturday, September 23, and will be under the presidency of Prof. Theodor Kocher, of the University of Berne. Among the subjects to be discussed are :—the value of the examination of the blood in surgery; the treatment of prostatic hypertrophy; surgical intervention in non-cancerous diseases of

the stomach; treatment of articular tuberculosis; the treatment of peritonitis; and the diagnosis of surgical diseases of the kidney. The official languages of the congress are English, French, German, and Italian. The English delegate is Mr. R. Harrison, 6 Lower Berkeley Street, W.

Science gives particulars of the sixth International Congress of Applied Chemistry, which is to take place in Rome in the spring of next year. The congress will be divided into eleven sections as follows:—Analytical chemistry, apparatus and instruments; inorganic chemistry and industries related thereto; metallurgy and mining, explosives; organic chemistry and industries related thereto; technology and chemistry of sugar; fermentation and starch; agricultural chemistry; hygiene; photochemistry, photography; electrochemistry, physicochemistry; laws, political economy and legislation in relation to industrial chemistry. The languages to be used in the discussion are Italian, French, German, and English. The minutes of the proceedings of the session will be in Italian. The secretary of the congress is Prof. V. Villavecchia, Central Customs Laboratory, Rome.

IT is stated in *La Nature* that the seventh International Congress of Zoology is to be held at Boston, U.S.A., in August, 1907, under the presidency of Prof. Agassiz. The Emperor Nicolas II. prize will be awarded on this occasion for monographs on the subject "Nouvelles recherches expérimentales sur la question des hybrides." The essays, either in manuscript or printed, should be addressed before June 1, 1907, to Prof. R. Blanchard, boulevard Saint-Germain, 226, Paris. The essays should be in French, though those written in German, Italian, or English will be admitted to the competition if accompanied by a summary in French.

IT has been decided by the Government of New Zealand to hold during the summer of 1906–7 (*i.e.* from November, 1906, to April, 1907) at Christchurch an international exhibition in which all nations are invited to participate. The object of the exhibition is educational, and to demonstrate the resources of the colony in food production, yield of minerals, the supply of raw materials, &c. Intending exhibitors may obtain full particulars from the secretary of the exhibition at Christchurch, New Zealand.

THE report of the special committee appointed by the Government of Bombay to consider the question of a public museum and library for Bombay has been issued. The estimated initial cost of the buildings alone is approximately ten lakhs, four of which are for the building devoted to art and archæology, and three for the science museum and public library respectively.

THE Paris correspondent of the *Lancet* states that a permanent committee to deal with the watering places and climatic stations in France has just been established by the Minister of the Interior. The committee, the honorary president of which is the Minister of the Interior, is to examine into the general needs of the places referred to, and to protect and develop them. The mayors and the medical men of the various watering places, the directors and the com: ittees of *sociétés thermales*, are liable each in his turn t. be summoned to serve on the committee for a period no. exceeding three years.

THE sum of 150,000 kroner has been given by Dr. F. G. Gade, of the University of Christiania, to the city of Bergen for the establishment of a laboratory of pathological anatomy.

IT is intended to celebrate the jubilee of Prof. D. I. Mendeléeff on August 30, this eminent man of science having completed his fiftieth year of public professional service on June 13 last.

M. J. DYBOWSKI, inspector-general of agriculture in the French colonies, has been elected an officer of the Légion d'honneur, and Dr. Giraud, head of the scientific mission to Martinique, has been raised to the dignity of chevalier.

A PORTRAIT medallion, in marble, of Sir William Geddes, the late principal of the University of Aberdeen, has been completed, and will be placed in the Geddes transept of the library at King's College. Its unveiling will probably take place at the beginning of the winter session. A meeting in furtherance of the proposed memorial to the late Prof. James Nicol was held recently in Marischal College, when a number of letters from geologists and old pupils of Prof. Nicol were read, the general tenor of which favoured the placing of a portrait tablet in bronze in the geological museum. There will be, it is hoped, a formal inauguration of the memorial during the centenary celebrations of next year.

THE council of the Royal Meteorological Society, being desirous of advancing the general knowledge of meteorology and of promoting an intelligent public interest in the science, has appointed a lecturer who is prepared to deliver lectures to scientific societies, institutions, and schools on payment of a moderate fee and the cost of travelling expenses, the subjects being:—how to observe the weather; weather forecasting; climate; rainfall; thunderstorms; meteorology in relation to agriculture, health, &c. The society is also prepared to lend and fit up a complete climatological station for exhibition, showing the necessary instruments in position and ready for use, and to lend in return for a nominal amount sets of lantern slides illustrating meteorological phenomena. Further particulars as to the scheme can be obtained from the assistant secretary of the society.

IN the report for 1904 of the hydrographer of the Admiralty which has just been issued as a Parliamentary paper, reference is made to the retirement, after twenty years' service, of Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S. During the year under review, 482 rocks and shoals dangerous to navigation were reported. Of these 65 were notified by surveying vessels, 31 by other ships in the British Navy, 8 by vessels not in the navy, 26 were struck, and 352 were reported by colonial and foreign Governments; 1139 miles of coast line were charted, and an area of 3993 square miles sounded. During the year the number of charts printed for use in the Royal Navy, the Government departments, and by the public reached the total of 661,590 copies, and 1245 notices to mariners were issued.

THE vast deposits of magnetic iron sands in the province of Taranaki, in New Zealand, containing 60 per cent. of iron and 8·14 per cent. of titanic acid, have long attracted the attention of metallurgists, and numerous attempts have been made to smelt the ores by making them into bricks by the admixture of various substances. In 1873 works on which 17,350*l.* were spent proved a failure. A new departure has now been made by the Galbraith Iron and Steel Company, Ltd., of Auckland, by adopting the electric furnace for the direct production of steel from these sands, and by invitation of that company we were afforded an opportunity of witnessing the furnace in operation at the Brush Electrical Engineering Company's works at Loughborough, Leicestershire, on July 19. In the furnace in-

vented by Mr. D. R. S. Galbraith, a constant stream of iron sand mixed with a given quantity of carbon is fed in at the top of the furnace, and travelling downwards by gravitation falls between and upon graphite bars forming resistances in the circuit, and finally leaves the furnace in the form of molten metal. The power is supplied by a single-phase alternator having an output of 100 kilowatts at 300 volts. This pressure is reduced to 18 volts by means of a transformer in close proximity to the furnace. The plant is, of course, an experimental one, and will require to be modified in several ways before it is used on a commercial scale.

DR. J. JOLY, F.R.S. (*Scientific Proceedings of the Royal Dublin Society*, vol. x., No. 34), being struck by the difficulties raised by the silting up of harbours on the south-east Irish coast, suggests the use of floating breakwaters moored to the bottom, but sufficiently deep to prevent response to the rise and fall of waves. They would thus be affected only by the tidal movements, and the dimensions "need not be extravagant where the conditions are not such as to require protection from deep-water waves." Two types are illustrated, the one cylindrical, with a submerged platform below, going down to about four fathoms, and the other more like a flat-bottomed ship, wider below and narrower above, with a hold full of water to increase the inertia. The author believes that in the seas inside the banks of Wicklow and Arklow such a mass might be assumed to be unaffected by wave-motion. The presence of such a breakwater, it is suggested, might even favourably increase the tidal scour.

WE have received from the Home Office part iv. of the general report on mines and quarries for 1903, containing comparative statistics relating to persons employed, output, and accidents at mines and quarries in the British colonies and in foreign countries. A good idea is given of the relative importance of mining in each country. In 1903 the number of persons engaged in mining and quarrying was 4,861,932, of which one-fifth were employed in the United Kingdom and one-third in the British Empire. More than half the total were employed in getting coal, of which the world's production was 881,002,936 tons. The world also produced 609,985 tons of copper, 491,672 kilograms of fine gold, 44,548,962 tons of pig iron, 892,899 tons of lead, 26,232,099 tons of petroleum, 12,818,253 tons of salt, 4,997,491 kilograms of fine silver, 98,295 tons of tin, and 570,440 tons of zinc. The death-rate from accidents throughout the world in 1903 is estimated at 1·87 per 1000, as compared with 1·93 per 1000 in 1902. For coal mines the accident death-rate of the United Kingdom is 1·26, and for the British Empire 1·33; while for France it is 1·02, for Germany 2·00, and for the United States 3·09. The death-rate for foreign countries generally is 2·14. It is evident that mining is conducted in Great Britain with a far smaller risk of accident to the workers than in most other countries.

THE meteorological results deduced from the observations taken at the Liverpool Observatory, Bidston, for the year 1904 have been published by Mr. W. E. Plummer. This observatory is maintained by the Mersey Docks and Harbour Board, and is one of the oldest and best equipped in the United Kingdom. Many years ago, the late Mr. W. W. Rundell prepared an elaborate discussion of the winds of Liverpool, which was published by the Meteorological Office. We notice that at the present time much attention is paid to this subject, which is naturally of the greatest importance for the shipping of the Mersey. Three anemometers of the Osler, Robinson, and Dines patterns are kept in efficient operation, and the maximum velocities and extreme pressures of the wind on the square foot are given for each day of the year, while the monthly and yearly summaries of the principal meteorological elements are expressed in imperial and metric measures. In the astronomical department, the transit instrument has been used continuously for the determination of time, and 2586 stars were observed during the year.

WE have received the annual report of the director of the Royal Alfred Observatory (Mauritius) for 1904; it contains the means and extremes of the meteorological elements and other general information; the actual observations will be published in a separate volume. From a table showing the observations of the direction of the various types of clouds, it is noteworthy that out of 821 observations the cumulus cloud was observed on 397 occasions, the cirrus cloud on only 66 occasions. The mean annual rainfall at ten selected stations was 13 inches below the average. The log-books of ships visiting the island were copied, and a daily journal of the weather over the Indian Ocean kept; it is noticeable that the number of vessels arriving annually between 1882 and 1904 have steadily decreased from 686 to 262. Photographs of the sun were taken daily whenever possible; 638 negatives were forwarded to the Solar Physics Committee. During the year 65 earthquakes were recorded. The observatory is still much troubled by depredations of white ants; numerous poisons have been tried for their extermination, the most efficacious being a solution of sal-ammoniac, turpentine, and methylated spirit, while the bookshelves are insulated with castor oil.

ONE of the scientific results of the annexation of the Philippines by the United States is the study of the ethnography of the group. Mr. W. Allan Reed has published a report on the Negritos of Zambales (vol. ii., part i., Ethnological Survey Publications, Manila, 1904). This is in reality only a sketch, as the author was only two months in the field, but his observations have undoubted value; doubtless a more thorough study will be made of these interesting people. The sixty-two plates which illustrate the paper add very considerably to its value, and by their means one can gain a very good idea of these jungle folk. A very useful album of Philippine types by D. Folkmar has been published by the Philippine Exposition Board, Manila; it contains eighty plates of photographs—full-face and side view of head—of inmates of Bilibid prison. The author has been careful to select typical examples from various districts, and opposite each plate are given certain measurements of the individual photographed, together with the averages of the same measurements taken on a large number of examples of that particular tribe. This is a very useful device, as it gives some sort of clue as to whether the individual figured is a fairly typical example of his tribe.

WRITING to *La Sicilia*, Prof. A. Ricco mentions that the crater of Etna is extending towards the north-west, and along the whole of the circumference, from north to west, is a great continuous fissure emitting steam and heated vapours. As the whole of the ground between this fissure and the margin must fall into the crater, he warns intending visitors of the need of caution in approaching the crater from the westwards, the direction from which it is most easily accessible.

IN the May number of the *Rend. Acc. Lincei* A. Pochettino describes the luminescence emitted by certain crystals under the action of radium and Röntgen rays.

The light given out by the platino-cyanides is, as a rule, vivid and partially polarised; it disappears directly the exciting cause is withdrawn. Crystals of scheelite, phosgenite, &c., show a feeble luminescence lasting several seconds after the removal of the incident rays.

IN part i. of a contribution to the *Scientific Transactions of the Royal Dublin Society,* vol. viii., p. 16, Prof. A. W. Conway discusses the partial differential equations of mathematical physics which in their general form are partial differential equations of the second order with constant coefficients reducible by transformation to three different classes. The problem has been attacked by Whittaker from the point of view of building up singular solutions from plane-wave solutions, but Prof. Conway adopts the reverse course, starting with the singular solution.

AMONG the results of the recent Röntgen congress at Berlin has been the authoritative adoption by a special committee of the following terminology:—Röntgenology = the study of Röntgen rays, Röntgenoscopy = observation by Röntgen rays, Röntgenography = photography by the rays, Orthoröntgenography in place of orthodiagraphy, Röntgenotherapy and the verb to röntgenise in their obvious meanings.

THE question "What is research?" is discussed by Prof. Henry S. Williams in the *Popular Science Monthly.* The author considers that research is not a special faculty possessed by the few, but a common faculty specially trained and systematically exercised by the few, for whom it becomes a tool of the highest value, and the means of opening up new fields of knowledge to mankind. At the same time, he directs attention to the detrimental effects of too much book learning on the power of research, and the need of a vivid imagination such as can be exercised and disciplined by the study of mathematics. Moreover, the man of research must be prepared to sacrifice his prospects in other directions and to work alone, "unappreciated and unapplauded" in most of his work, and Prof. Williams finally cautions teachers against tempting mere enthusiasts to undertake a task which requires for success the toughness of a soldier, the temper of a saint, and the training of a scholar. The subject of the article is one which might be very well discussed further in view of the large amount of "research," falsely so-called, which is now being turned out by persons not possessing any of these qualities, with the great danger of lowering public estimation of the importance of work of real scientific value.

DR. J. HETTINGER, writing from London in the *Physikalische Zeitschrift* for June 15, describes a new electrical connection for intensifying the resonance effects in wireless telegraphy.

THE Mathematical Association has reprinted the report of its committee on the teaching of elementary mathematics. In the same pamphlet are reproduced the "Little Go" regulations in geometry. We observe that Cambridge advocates the "hard pencil," which leads to so many indistinct figures in candidates' answers. A valuable mental training is thus omitted in not requiring candidates to make their drawings, as well as written work, clear and distinct to others. Moreover, even a soft pencil with a thick point has an advantage in showing that in any *constructive* proof lines must necessarily be of a certain thickness, and the conclusion is only established as approximately true. The beginner who learns this will be the better able to appreciate the deductive method at the proper time.

THE surfaces obtainable by the deformation of a hyperboloid of revolution of one sheet are discussed by Prof. Luigi Bianchi in the *Atti* of the Lincei Academy, xiv., 10. The determination of these surfaces is shown to depend on that of a certain class of imaginary pseudospherical surfaces, and the difficulty of the problem is reduced to that of characterising these latter surfaces, and thus presenting the final transformation formulæ in a real and definite form.

THE Institution of Electrical Engineers has published an address delivered to its students in January last by Mr. James Swinburne, M.Inst.C.E., on "The Theory of Electricity and the Value of its Study to Engineers." In it the author emphasises the desirability in many cases of mathematics being learnt through its applications, and points to the theory of electricity as affording a valuable introduction to the study of many of the most important branches of mathematical analysis. In conclusion the author says:—"I feel confident that enough has been said to make it evident that a modern engineer cannot consider his technical equipment complete without some knowledge of the theory of electricity; and if electrical development continues at the present rate it may soon be the most important branch of the science of engineering."

Biologisches Centralblatt of July 1 contains the report of an interesting address on the use and place of hypotheses, suppositions, and problems in biology, delivered by Mr. J. Reinke at the opening session of the International Botanical Congress at Vienna on June 12. That theories and hypotheses have a great and important place in science—indeed, that they are absolutely essential to its proper advance—the lecturer fully admitted; but, he added, it is necessary to remember that they are nothing more than theories, otherwise there is the greatest danger of their proving a hindrance and an illusion. A notable instance of this danger is afforded by the numerous phylogenies of animals and plants which are published from time to time, and are too often accepted as though they were solid facts, instead of being in most cases mere hypotheses, based not unfrequently on the very slenderest of foundations.

A YEAR ago we referred to notices of the occurrence of the striped hawk-moth in this country, and we observe that in the *Entomologist* for June and July several instances of the capture of the same species this season are mentioned. Possibly this handsome moth may become established in the south of England, at least for a time. In the July number Mr. G. W. Kirkaldy continues his popular synopsis of British water-bugs.

To the *Journal of Conchology* for July Mr. A. D. Darbishire contributes a discussion on Prof. Lang's experiments in breeding with the two common garden snails *Helix hortensis* and *H. nemoralis.* The writer denies that these experiments confirm the truth of Mendel's doctrine, *stricto sensu*; that is to say, they do not afford conclusive evidence of the existence in the gonads of *H. hortensis* of definite unit-bearing elements representing either five-banded or unbanded shells. It is added that much interest will attach to the description of the characters of the "dart" in the hybrid between the two species in question.

In the course of a paper published in the June number of the *American Naturalist* on the advantages presented by the common skate as a subject for demonstration to anatomical classes, Dr. H. W. Rand takes occasion to emphasise the importance of selecting generalised, in place of specialised, species for such demonstrations. A skate or a dog-fish is thus to be preferred to a bony fish, and similarly a salamander to a frog. As regards the choice between a skate and a dog-fish, although the former is a much more specialised type than the latter, it has the advantage of being more easily obtained and of being available for the greater part of the year. Moreover, its very specialisation happens to be an advantage to it as an object for demonstration, for not only does its flattened form render it admirably suited for dissection, but most of its organs are brought more or less nearly into one horizontal plane, so as to be capable of demonstration almost as if drawn in a diagram. Apropos to this article is a second, by Messrs. Rand and Ulrich, on posterior connections of the lateral vein in the skate. To the same issue Mr. E. W. Berry contributes an article on fossil sedges and grasses, with the description of a new Carex; and Mr. J. A. Cushman one on the fossil crabs from the well known Miocene beds of Gay Head, Mass., described long ago by Dr. E. Hitchcock, and subsequently by Sir C. Lyell.

An interesting paper on the gradual dissociation of mellitic acid is contributed by A. Quartaroli to the current number of the *Gazzetta Chimica Italiana*, vol. xxxv. p. 470. The author has measured the rate at which cane sugar is inverted by mellitic acid and by the corresponding mono-, di-, tri-, tetra-, and penta-sodium salts in one-tenth molecular solution. If the velocity constant for the free acid is represented by 100, the values for the various salts in the order given are respectively 40·5, 14·3, 2·2, 1·5, and 1·04. These numbers may be taken as a measure of the relative tendencies to ionisation of the six successive acid hydrogen atoms. Taking the ratio of the first to the second, of the second to the third, &c., the series 2·47, 2·82, 6·49, 1·47, 1·43 is obtained. These numbers are interesting, and the occurrence of a maximum value in the middle of the series suggests that the dissociation of mellitic acid is of abnormal character.

During the past week the Royal College of Surgeons of Edinburgh has been celebrating its four hundredth anniversary. The college, which is the oldest medical or surgical corporation in the United Kingdom, dates from July 1, 1505. The Royal College of Physicians of London, the next in point of age, was officially established some thirteen years later, *i.e.* in 1518. The current number of the *Lancet* contains an interesting account of the older institution.

The third number of the second volume of the Investigations of the Departments of Psychology and Education of the University of Colorado has reached us. Among other contributions, those in which Prof. Francis Ramaley deals with the teaching of botany and zoology, and Prof. Chas. A. Lory with the teaching of physics, are of special interest.

We have received a copy of "Southern Rhodesia, Information for Settlers," a small handbook issued by the British South Africa Company. The title sufficiently indicates the nature of the contents of the book, but it is worth noting that many of the numerous illustrations are of considerable geographical interest and value.

The report of the Royal Cornwall Polytechnic Society for 1904 has just been published, and bears testimony to the continued vitality of the society. One of the chief features of the society's activities during the year was its exhibition, in connection with which addresses and papers were given on electrical research, practical bee-keeping and management, and the geology, minerals and mines of Lelant, St. Ives, and Zennor. The first and last of these communications are to be found in the report before us, as is also an informing paper by Mr. C. C. Bignell on the aphides with their food plants; the volume likewise contains a detailed report of the work accomplished at the Falmouth Observatory.

The new number of the *Quarterly Review* contains only two papers dealing with scientific subjects, one on the national coal-supply, the other, by Sir Charles N. Eliot, on the Buddhism of Tibet. Both communications are very informative and eminently readable.

Messrs. R. and J. Beck, Ltd., of Cornhill, have just issued a catalogue of microscopes and apparatus specially suited for metallurgical work.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in August:—

Aug. 2. 1h. Mercury at greatest elongation (27° 18′ E.).
" 2. 12h. 28m. to 14h. 6m. Transit of Jupiter's Sat. III. (Ganymede).
" 4. Pallas in opposition to the sun.
" 11–13. Epoch of Perseid meteoric shower (Radiant 45° + 57°).
" 12. Saturn. Major axis of ring = 43″·82, Minor axis = 7″·47.
" 14. 10h. Venus in conjunction with Neptune, Venus 0° 48′ S.
" 14. Partial eclipse of the moon visible at Greenwich.
14h. 39m. First contact with shadow.
15h. 41m. Middle of the eclipse.
16h. 43m. Last contact with shadow.
Magnitude of eclipse = 0·292. Moon sets 16h. 53m.
" 15. 9h. Saturn in conjunction with moon, Saturn 1h. 43m. S.
" 15. Venus. Illuminated portion of disc = 0·680, of Mars = 0·854.
" 16. 11h. 49m. Minimum of Algol (β Persei).
" 19. 8h. 38m. Minimum of Algol (β Persei).
" 22. 21h. 0m. Saturn in opposition to the sun.
" 23. 12h. 5m. to 12h. 46m. Moon occults σ^2 Tauri (Mag. 4·8).
" 30. Total eclipse of the sun, partly visible at Greenwich.
11h. 49m. a.m. Beginning of the eclipse.
1h. 3m. p.m. Middle of the eclipse.
2h. 15m. p.m. End of the eclipse.
Magnitude of eclipse = 0·786. Sun's altitude at noon = 48°.

Photographs of the Martian Canals.—Since the opposition of Mars in 1901, persistent efforts have been made at the Lowell Observatory to secure photographs of the planet on which the canals could be seen definitely. After making a number of exposures with a camera in which the film was continuous, so that a large number of short exposures—as in the bioscope—could be made on the one film, Mr. Lampland succeeded in obtaining negatives which demonstrate indubitably the actual existence of the "canals" Nilosyrtis, Pyramus, Casius, Protonilus, Astaboras S., and Thoth. In addition to these, the "regions" Syrtis Major, Mare Erythræum, Mare Icarium, Hellas and the north polar cap, and the "oasis" Lucus Ismenius are plainly discernible. A photographic print from a negative secured on May 11 at 19h. 44m.–48m. (G.M.T.) on which these features are visible is affixed in the *Lowell Observatory Bulletin*, No. 21, accompanied by a drawing made by Mr. Lowell immediately before the exposure was made. Other photographs secured

show other canals, and Mr. Lampland is to be congratulated, in company with Mr. Lowell, upon thus securing unquestionable evidence of the actual existence of these features.

A point of special interest to planet observers is that whilst trying to obtain these photographs the observers found that the restriction of the aperture employed, by its elimination of the evil effects of atmospheric vibrations, more than counterbalanced the inconvenience caused by the diminution of light-gathering power and the consequent increase of the length of the exposures, a result which confirms the conclusion previously arrived at by Mr. Lowell from visual observations.

DUTCH OBSERVATIONS OF THE CORONA.—Parts iii. and iv. of Prof. Julius's report on the observations made by the Dutch expedition in Sumatra during the total solar eclipse of May 18, 1901, minutely describe the apparatus and the methods of procedure employed in examining the coronal radiations for polarisation effects and for the determination of the amount of heat radiated by the eclipsed sun.

A double-image polarimeter of the Cornu pattern, slightly modified, was employed to examine the polarisation at different points of an image of the corona. The points examined were situated at different distances from the sun's limb, and the position of each was carefully recorded. The results showed that the coronal rays were more strongly polarised at some distance from the limb than nearer to it, whilst at greater distances the polarisation again decreased. A discussion of some experiments, performed after the eclipse, on the depolarising effect of haze and clouds showed that this effect was practically negligible.

The observations of the total heat radiated by the eclipsed sun were made with a thermopile pointed directly to the corona, but clouds robbed the observations of any definite result. So far as they go, the resulting figures show that the heat radiated at totality is not so great as that received from the full moon, and that a very striking increase occurred after the third contact.

THE NORTH POLAR SNOW-CAP ON MARS, 1904-5.—Observations of the north polar cap of Mars were made at the Lowell Observatory by Messrs. Lowell and Lampland during the period November, 1904, to May, 1905, and the observers' notes for each night are given in full in No. 20 of the *Lowell Observatory Bulletins*.

One remarkable feature observed was a white collar which surrounded the cap during the latter half of January. Mr. Lowell explains this phenomenon by the conjecture that it is a belt of spring haze which surrounds the cap during the hotter months of the melting, the cap proper being bordered by a blue belt of material (probably water) produced by the melting of the snow. Several subsidiary patches of snow were left behind by the receding polar cap, and became prominent features.

Of these, one in longitude 206° was especially marked, and was recorded in exactly the same longitude by Schiaparelli in 1888, and independently at the Flagstaff Observatory in 1901 and 1903.

VEGETATION AND THE SUN-SPOT PERIOD.—Since 1871 M. Camille Flammarion has each year recorded the dates on which the chestnut trees in the avenue of the Paris Observatory have burst into leaf and flowered. Plotting the results of his observations with the sun-spot curve on the same year-scale, he found that the variation of the dates of the different phases of the annual arboreal phenomena agreed very closely with the latter curve, the leaf-buds bursting and the flowers appearing earlier at those epochs when the sun-spot *maxima* occurred. The details of the observations and the method employed in reducing them are given in the July number of the *Bulletin de la Société astronomique de France*.

VISIBILITY OF THE DARK HEMISPHERE OF VENUS.—In a paper on the influence of the solar-activity variations on the planets, M. Hansky directs attention to the greater visibility of the dark hemisphere of Venus during epochs of maximum solar activity. According to the theory of Arrhenius, electrified ions emitted by the sun cause the phenomena of terrestrial magnetic storms and auroræ. Applying the same theory in the case of Venus, M. Hansky suggests that during the periods of solar maxima the dense atmosphere of that planet is rendered more phosphorescent, and, therefore, more easily visible, by the increased solar activity. He further suggests that, in order to test this theory, astronomers should observe the planet as often as possible during the present sun-spot maximum (*Bulletin de la Société astronomique de France*, July).

DETERMINATIONS OF METEOR RADIANTS.—Some interesting results of meteor observations are recorded in No. 4032 of the *Astronomische Nachrichten* by M. Eginitis, of Athens, and by Prof. A. A. Nijland, of Utrecht.

M. Eginitis observed the Perseid, Leonid, and Andromedid showers of 1903 and the Perseid shower of 1904. He gives the time of observation, the number, colour, magnitude and relative velocity of the meteors recorded, and the position of the determined radiant on each date, directing special attention to any objects which were, for any reason, extraordinary. On August 11, 1904, several meteors were seen to proceed from a radiant near to α Persei, and these were, in general, whiter and brighter than those from η Persei, the latter being fainter and of a reddish-yellow colour, and generally falling in pairs.

Prof. Nijland's results deal with the Lyrid, Perseid, and Leonid showers of 1902, 1903, and 1904, and he gives the results for each night of observation and the positions deduced for the respective radiants.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE summer meeting of the Institution of Naval Architects was held last week in London, the usual sittings for the reading of papers taking place in the theatre of the Society of Arts. The following papers were on the programme for reading and discussion:—Tactics and strategy at the time of Trafalgar, by Admiral Sir Cyprian Bridge; the ships of the Royal Navy as they existed at the time of Trafalgar, by Sir Philip Watts, Director of Naval Construction; the classification of merchant shipping, illustrated by a short history of Lloyd's Register, by H. J. Cornish, chief ship surveyor to Lloyd's Register; experiments with models of constant length and form of cross section, but with varying breadths and draughts, by Lieut.-Colonel B. Rota, Royal Italian Navy; experiments upon the effect of water on speed having special reference to destroyers recently built, by Harold Yarrow; deductions from recent and former experiments on the influence of the depth of water on speed, by W. W. Marriner; the failure of some large boiler plates, by J. T. Milton, chief engineer surveyor to Lloyd's Register; a comparison of the performances of turbines and reciprocating engines in the Midland Railway Company's steamers, by William Gray.

It was also arranged that visits should be paid to the following works:—Siemens Bros. and Co.'s Telegraph and Electrical Instrument Works, near Woolwich; Vickers, Sons and Maxim Ordnance Works, Erith; J. and E. Hall's Refrigerating Machinery Works, Dartford; Yarrow and Co.'s ship-building yard and marine engine works, Poplar; John I. Thornycroft and Co.'s ship-building yard, marine engine works, and motor-car works, Chiswick. Visits were also paid to the P. and O. mail steamer *India*, lying in the Tilbury Docks, and H.M.S. *Black Prince*, built by the Thames Iron Works, and lying in the Victoria Docks. The last day of the meeting, Friday, July 21, was occupied by a visit to Portsmouth Dockyard.

The first sitting during the meeting, when the three first papers on the list were presented, was held on Wednesday, July 19, the president of the institution, the Right Hon. the Earl of Glasgow, occupying the chair. These papers, as will be gathered by the titles, were chiefly of historical interest. In this centennial year of Trafalgar it was, no doubt, appropriate for the institution, which is so largely naval in its composition, to include in its programme papers of the nature of those contributed by Sir Cyprian Bridge and Sir Philip Watts; but how far they have any scientific bearing on naval strategy or tactics of the present day is a question that is evidently open to discussion. It would appear that a large section of naval officers hold that the lessons of the past era of masts and sails should be applied with little modification

to the present day. For example, Admiral Sir Edmund Fremantle said that the tactics and strategy at the time of Trafalgar taught lessons which would never die, and Admiral Custance remarked that all the lessons of the past in naval warfare have a bearing on the present day, it being quite immaterial whether vessels were moved by steam or sail. On the other hand, there are some who hold that the disciples of what has been described as the "teachings-of-history" school carry their reverence for the past to an excessive degree, and that a too blind following of the tactics and strategy of the great admirals of the past may lead to disaster. Sir Philip Watts, in the course of his paper, pointed out that "steam propulsion, in all its various forms, shell fire, iron and steel armour, steel hulls, breech-loading and rifled guns, torpedoes, mines, high explosives, electrical appliances, and submarines" have all been introduced since the day of Trafalgar; and though he did not press any moral from these changes, his predecessor at the Admiralty was a little more explicit, as it was possible for one no longer trammelled by the rules or etiquette of office to be. Sir William White said in the discussion that while he agreed with Sir Cyprian Bridge that the teachings of history were valuable, it was necessary to allow for changes brought about by time. He did not think such a course was followed on all occasions.

Mr. Cornish's paper, as a record of the past by a competent authority, is one which should prove of considerable value to the student and historian of ship-building. The author did not urge its reading as time was short, and it was accordingly taken as read.

Colonel Rota's paper was the first taken at the evening sitting of Wednesday, July 19. It formed but a part of a very big subject, and was in the nature of an addition to Mr. R. E. Froude's paper on model experiments, read last year. The experiments briefly described by Colonel Rota were made with five models at the Royal Italian Dockyard, Spezia. It would be difficult to give the results of the inquiry without going into the whole question, but it may be stated that the author, without attempting to draw any general deduction, has practically concluded that in the unlimited series of forms which may be derived from a given form of hull by changing the vertical and horizontal cross sections scale—provided that the area of cross sections remains constant—there is a range of ratio of beam to draught, very close to that corresponding to the least wetted surface, within the limits of which there is not any sensible variation in the value of the resistance constant, that is, the corresponding E.H.P. There was no discussion on this paper, but Sir William White had written to Mr. Dana, the secretary, endorsing the author's plea for the publication of results of a purely scientific nature.

The two papers contributed respectively by Mr. Harold Yarrow and Mr. W. W. Marriner were no doubt the chief attraction during the meeting, and the little theatre of the Society of Arts was crowded to its full capacity by those anxious to benefit by the investigations carried out by Messrs. Yarrow and Co. Both papers referred to the same experiments, the authors having been engaged together on the work. Mr. Marriner, as is well known, is the chief of Messrs. Yarrow's scientific staff, whilst Mr. Harold Yarrow is still a student of the institution, and it is worth noting that his paper is the first contribution to the *Transactions* by a student. The data given possesses the merit of being both of scientific and practical interest. It has for some time past been recognised that depth of water has a considerable influence on the speed of steam ships, and Government contractors have lost considerable sums of money through failure to attain speed on the official measured miles. The scientific interest of the subject is unlimited, the problem involving the study of the natural laws governing wave-making and fluid resistance. It is to be hoped that ship builders and ship owners—now they have had placed before them so striking an example of the value of scientific research upon the practical results at which they aim—will do something tangible to help forward an inquiry into the influence of physical laws upon the resistance of vessels progressing in water. It is not creditable to the ship owners and ship builders that they should be beholden to the generosity of a private firm of torpedo-boat builders for information on these points, especially as such information cannot be obtained without the expenditure of several hundreds of pounds. The exclusive knowledge of the facts set forth in the two papers would prove a valuable asset to Messrs. Yarrow and Co. by giving them a distinct advantage over their competitors, and it is therefore more creditable to them that they have made the details public. It is, however, the greatest reproach of all to us, as the leading maritime nation, that Mr. Yarrow should have been under obligation to a German ship-owning firm for the facilities needed to make the investigation complete. Had it not been for the hospitality of their experimental tank offered by the North German Lloyd Company, the valuable information now at the command of ship designers would not have been forthcoming, for there is no tank of the same nature in this country which could have been used.

The experiments upon which the two papers were founded arose through Messrs. Yarrow and Co. having failed to get the contract speed of 25½ knots with destroyers built for the Royal Navy when they were tried on the Maplin mile off the mouth of the Thames. The builders, anticipating that the limitation in depth of water was accountable for the want of success, surveyed on their own account a mile near Dover, the section posts being placed on the cliffs. Here, in a greater depth of water—50 feet at low tide—the contract speed was reached, the vessels running a great part of the time in quite deep water outside the Goodwins. It should be explained that the trials last over four hours, and only six runs are made on the measured mile. On these six runs is found the number of revolutions needed to cover a mile, and then by counting the revolutions the distance steamed can be known. Although the contract was fulfilled, the results were not altogether satisfactory to the contractors, and Mr. Yarrow determined to have tank experiments made, testing a model of the destroyer at depths corresponding to 20 feet, 30 feet, 45 feet, 60 feet, and 90 feet respectively. The results were shown by diagrams thrown on the screen by the lantern, there being curves for speeds and for effective horse-power at the above depths. The results were somewhat remarkable. Each curve showed a distinct hump, indicating that when a certain speed was reached the power needed for an increased speed rose with enormous rapidity. This, of course, was in accordance with previous experience, and it was also to be expected, as shown by the diagram, that the hump would occur at lower speeds with shallower water; thus at 20 feet depth the top of the hump was at about 16 knots, at 45 feet it was about 20 to 21 knots, and at 90 feet the steepest part was from 20 to 24 knots. As the depth increased the curve became fairer.

The interesting feature brought out, however, was the fact that at a certain speed, depending on the depth of water, for a time the power decreased as the speed advanced. Thus in a depth of 20 feet, at a speed of about 15¾ knots, 2000 horse-power was needed; when the speed had been increased by approximately another knot the power developed was about the same, whilst at 17½ knots the demand for power had fallen off appreciably, and it was not until 18 knots was reached that the 2000 horse-power was again required, and after this the curve rose steadily. With a depth of 30 feet the descent of the curve was even more marked, about 2500 horse-power being needed for approximately 17½ knots and for 20 knots also. Comparing the powers required for speeds at different depths, we find also some remarkable results. At 18 knots 2500 horse-power was needed when the water was 30 feet deep, whilst when it was but 20 feet only 2000 horse-power had to be developed to reach the same speed, thus reversing the popular idea that the deeper the water the easier the boat would run. Again, at 20 knots, and when the water was 20 feet (and also when the depth was about 30 feet—the two curves approximately coinciding here), 2500 horse-power was needed, but to get the same speed with a depth of 45 feet about 315 horse-power was needed. Passing at once to the higher speed of 26 knots, we find that the highest power is needed when the boat is steaming in deepest water. After crossing and re-crossing each other, the curves for four depths (20 feet, 30 feet, 45 feet, and 60 feet) come fairly well together, having got

over all the humps at about 25 knots, where there is a range of about 200 horse-power. The curve for 90 feet of water is, however, for 5000 horse-power at 26 feet, or about 500 horse-power above the next highest curve. It would therefore pay better, according to these model experiments, to run a 26-knot trial of a destroyer in a depth of 20 feet to 60 feet rather than at a depth of 90 feet; the saving in power for the given speed due to the use of shallower water would be about 600 to 700 horse-power.

We have been obliged to depart from the text of Mr. Harold Yarrow's paper in order to give the facts contained in his diagram. Limits of space prevent detailed reference to other particulars brought forward by these suggestive trials, but enough has doubtless been said to show their interest and the wide field for further investigation that is afforded by the numerical data now at command. It will be remembered, as Mr. Harold Yarrow pointed out, that the tank experiments were made in the usual way without propellers, and this would doubtless have a considerable influence on the results; but possibly a way may be found, as suggested by Sir William White, to add the propeller, and so bring the tank conditions more nearly akin to actual practice. It will be remembered that the late Mr. Froude proposed to run a propeller, worked by independent mechanism, at a speed of revolutions corresponding to that of actual practice, the model, of course, being towed by the carriage.

Mr. Marriner's investigation of the model results showed that they should, as Mr. Harold Yarrow said, "be accepted with caution." In order to check these tank data progressive trials were made with an actual destroyer on a carefully selected course off the mouth of the Thames. Four tugs were anchored to mark the course, which extended from the East Girdler buoy across the Tongue Sand to a point east of the extreme north-east point of the Tongue Spit. This gave water of depths varying between about 14 to 16 feet over the sand, and 100 to 102 feet in the Queen's Channel. The revolutions of the engines, the fore and aft inclination of the vessel, and the height of the stern wave were noted, indicator diagrams also being taken. The data thus obtained at varying mean speeds were given by means of diagrams thrown on the screen. We have not space to repeat all the records, but will take as an example the run made at a mean speed of about 22·2 knots, the steam pressure being 140 lb. In running from rather less than 50 feet depth into water of 20 feet, the revolutions increased from about 305 to more than 325; the inclination in a length of 20 feet decreased from approximately 5½ inches to 4¼ or 4½ inches; and the approximate height of the stern wave fell from 20 inches above the deck level to a little more than 10 inches below the deck level, or about 2 feet 6 inches. Naturally any increase or reduction of resistance to the vessel would be accompanied by increase or reduction in the rate of revolutions of the engine, the steam pressure being constant. Increased height of stern wave and greater inclination are also signs of increased resistance and a greater demand for horse-power.

It would be difficult to deal adequately with Mr. Marriner's paper within anything approaching the space we have at our disposal, and without the diagrams by which it was accompanied. We can only hope, therefore, to give an idea of its scope, and refer our readers to the original in the published *Transactions* of the institution. The contribution consisted of a discussion, on a scientific basis, of the results contained in the preceding paper, the size of waves made by a vessel in her passage being a measure of the power absorbed in their formation. As the height of the stern wave was seen to increase when the resistance of the ship increased abnormally, it was to be assumed that anything which tended to retard the formation of waves would reduce the loss from wave making. The author cited the work of W. Froude and his son, R. E. Froude, of Lord Kelvin, D. W. Taylor, of the United States Navy, and Prof. Horace Lamb. The formula for relation of length to speed of ordinary repeating waves in deep water was set forth, and also the more complicated equation for shallow water. The equation showing critical depth for speed and critical speed for depth was given, and the conclusion was drawn (supported by Scott Russell's equation for the solitary wave in canals) that "the wave at the critical speed changes from the repeating to something approaching the solitary type."

The author next considered the waves accompanying the vessel. Transverse waves should tend to become longer and longer for the same speed as the depth diminishes until, at the critical depth, these should be of the isolated type. In shallower water, past the critical depth, there would be no transverse wave corresponding to the critical depth. Actually as the waves became longer if they did not lengthen as rapidly as investigation would lead one to suppose they would be travelling faster than their natural speed, and must be dragged by the boat. The increased resistance on approaching humps in the curve supports this view. The isolated wave is non-repeating, and exists only under certain relations of depth to speed. After passing the critical point the transverse wave disappears, being replaced by confused water. The paper was accompanied by diagrams illustrating these points, and it was considered a fair deduction that the waves formed by a ship closely follow the laws of waves in open water. The effect of the vertical sides of a canal in diminishing the loss of energy was pointed out by the author, and the manner in which the restricted width of a tank might have a similar effect was noted. The interference of the bow-wave system on the stern-wave system was discussed, it being shown that the union of the bow and stern waves (the crests coinciding) resulted in a large resultant wave which would carry away a great deal of energy. The velocity of diverging waves is much less than the speed of the vessel, speeds attained up to the present not being high enough for waves to approach the critical speeds for the depths in which vessels usually run. Diverging waves apparently constitute the principal wave-making resistance at speeds beyond the critical combinations of depths and speeds under consideration. The final conclusions of the author were as follows:—"(1) The critical combinations of depth and speed do not depend on the size of the vessel. (2) Of these critical combinations there is, for every vessel, one more serious than the others, and where this worst combination occurs depends largely on the length of the vessel. (3) The depth to be avoided is given by the equation $d = V^2/10$, and the resistance diminishes in both greater and lesser depths. The further away from this bad depth the better, especially on the deep side."

In the course of the discussion which followed the reading of these papers, Mr. A. F. Yarrow, in conformity with a suggestion made by Sir William White, proposed, and Mr. S. W. Barnaby seconded, a resolution that the Admiralty be urged to erect a measured mile, where ample depth might be found, in proximity to Chatham and the Thames. This resolution was put to the meeting by Sir John Durston, who occupied the chair, and was carried unanimously. It was but the logical outcome of the facts brought forward. The measured mile in the Clyde at Skelmorlie has ample depth of water, and is, as Sir William White said, the only satisfactory mile for high-speed trials; a fact which, it is acknowledged, gives the ship-builders of that district a manifest advantage over those of other centres. Mr. Barnaby stated that when a destroyer built by his firm, John I. Thornycroft and Co., was tried on the Skelmorlie mile an increase of speed of 1 knot was obtained over that reached under the best conditions on the Maplin mile, whilst an increase of 3 knots was reached as compared to running on the Maplin when the state of the tide was most unfavourable. Sir William White, in a letter to the secretary, read at the meeting, heartily endorsed the suggestion of a deep-water measured mile off the Thames. He also pointed out, with great regret, that it was necessary for Messrs. Yarrow to go to Germany for their tank experiments, and trusted that the fact might furnish a fresh incentive towards the establishment of a research tank at the National Physical Laboratory.

In the discussion on the technical details of the two papers, besides those mentioned, Mr. J. H. Narbeth, of the Admiralty, Mr. R. Saxton White, Captain Jackson, R.N., Controller of the Navy, Mr. W. H. Whiting, chief constructor, and Prof. Biles took part. Generally it may be said the views expressed by the authors were not disputed, although Sir William White did not quite agree

with Mr. Marriner as to the importance the latter attached to the comparative narrowness of the tank.

On the Thursday's sitting Mr. Milton's paper on fractures in large steel boiler plates was read and briefly discussed. It gave particulars of the failures, the reasons for which could not be explained, of certain plates, and therefore were, naturally, attributed to "heat treatment." It is a term of exceeding comfort to the steel maker and the engineer alike, for the former is able to put the blame on the latter, and the latter to put the blame on the former, as no one can prove where the injudicious heat treatment occurred. The controversy is an old one, dating back, at any rate, to the days of the *Livadia's* boilers. Mr. Milton's paper is a suggestive contribution, and the facts he records may carry us some way towards a solution of the problem in the more or less distant future.

Mr. William Gray in his paper gave particulars of the performances of certain steamers fitted with Parsons' steam turbines. These were set forth in a table, which, as the author said, "treated the matter from a purely commercial standpoint." The discussion was largely of the same character.

The only remaining paper was not on the original programme, but was read at the conversazione which brought the proceedings to a conclusion on the Thursday evening. It was a contribution by Captain R. H. Bacon, R.N., entitled "Notes on the Causes of Accidents to Submarine Boats, and their Salvage." This paper, in harmony with the circumstances in which it was read, was of a popular nature, and was designed to show to the public at large that undue anxiety as to the safety of submarine boats is not warranted by the conditions under which they are employed. Dealing with the probability of water entering the hull through the hatch (the cause of four serious accidents through which these boats have foundered), the author pointed out that the fitting of another water-tight hatch at the base of the tower reduced the chance of accident in the future. The danger from grounding, he said, "was not very great," whilst the risk of the hull being crushed by the boat diving to too great depths argued the failure of the diving rudders, or too much water ballast. As to explosion through leakage of petrol, "in a properly designed system leaks should be practically non-existent." Another possible cause of explosion is due to hydrogen given off when batteries are being charged, but as this operation is carried on only when the boat is opened up for ventilation, "no danger exists." Altogether Captain Bacon's lecture was most reassuring, and it is pleasant to learn that his optimistic views are fully shared by his colleagues in the Service, both officers and men. The risk of sinking—involuntary sinking—being so small, it is of less consequence that only over a limited area near shore is it possible to recover a submarine boat once she has gone to the bottom. For this reason Captain Bacon considers it inadvisable that the Royal Navy should have a salvage plant of its own.

THE CONGRESS OF THE ROYAL INSTITUTE OF PUBLIC HEALTH.

THE congress of the Institute of Public Health, which this year was held in London under the presidency of the Marquis of Londonderry, attracted a large number of visitors, and much good work was done in the various sections which met at the Polytechnic and at King's College.

In a brief space it is impossible to deal adequately with the valuable discussions and papers read.

Sir James Crichton Browne, F.R.S., in his presidential address to the section of preventive medicine, chose as his subject the prevention of senility. It was, he declared, on the reduction of the death-rate that the potency of preventive medicine, as hitherto applied, stood forth conspicuously declared, and that the promise of its future sovereignty might be discerned. Fifty years ago the death-rate of England and Wales stood at 22·5 per 1000 persons; in 1903 it had dropped to 15·4—a fall of 7·1 per 1000, representing, on the estimated population of 1903, a saving of upwards of 223,000 lives per annum. As an exceptionally low rate of infant mortality had been maintained for two successive years, it might be hoped that the warnings uttered as regards infant hygiene, and more particularly infant feeding, were beginning to take effect.

It was, however, during the first half of life that the great fall in the death-rate had taken place. It was a remarkable fact that in men, at all ages from forty-five to seventy-five, there had been a startling rise in the death-rate, and that in women, from fifty-five upwards, it had been practically stationary. At the ages when we should have welcomed a rise in the death-rate, and at which only, in a hygienic Utopia, death ought to occur—eighty-five and upwards—it had fallen. Some of the nerve centres went on evolving until middle life, *e.g.* the hand and arm centres. He had ascertained that among certain classes of operatives in Birmingham the hand and arm centres did not reach their full maturity until about the thirtieth year. Similarly with the weavers of Bradford and the potters of Staffordshire. At about forty-five the productiveness of the manufactory hand generally began to diminish, and after that it contracted in an increasing ratio as time went on. The hand-failure of our operatives after forty-five was premature, and due to excessive wear and tear of the mechanism regulating manual movements. But there were other centres in the brain which, reaching maturity later, retained their power longer. Orators secured their greatest triumphs between forty-five and fifty-five, and it was with musical expression as with oratory.

The best antiseptic against senile decay was an active interest in human affairs, and those kept young longest who loved most. The natural evolution of our nerve centres was largely interfered with and too often arrested by unfavourable environment and deleterious habits of life or methods of work. It was a good working hypothesis that the natural life of man was one hundred, and that so far as it fell short of that it was "curtailed of fair proportion." Every man, he thought, was entitled to his century, and every woman to a century and a little more.

Dr. Francis Galton, F.R.S., in a paper on physical records, suggested that on February 29 in each leap year there should be school reunions at which there might be an opportunity for reviving early friendships, and at which, at the same time, the anthropometric and other records of the pupils might be added to.

Each old boy would be represented by an envelope stored in the school library. This would contain his anthropometric record to date, and he would be given printed forms, containing a few well considered questions—health, profession, preferments, marriage, children, and general remarks—and would be asked to forward the filled-in forms to the school.

Many papers were read on infantile mortality and on municipal milk depôts.

In the unavoidable absence of Sir William Broadbent, a discussion on sanatoria for consumptives was opened by Dr. T. N. Kelynack, physician to the Mount Vernon Hospital for Consumption. To illustrate the enormous economic waste to the community caused by pulmonary tuberculosis, Dr. Kelynack mentioned that in the metropolitan district alone 40,000 people died of the disease every year, and the monetary loss to London had been estimated at 4,000,000*l*.

The provision of adequate assistance for the consumptive poor demanded urgent attention. Sanatoria or hygienic hospitals undoubtedly secured the best conditions for the arrest and alleviation of the disease. At present we were just muddling along, with no satisfactory organisation of our resources and no rational cooperation.

A resolution was unanimously adopted urging the Government to appoint a commission to deal with the subject of the sanatorium treatment of the poor.

The presidential address in the section of chemistry and bacteriology was given by Prof. R. T. Hewlett. It was a plea for the recognition of the place of the specialist in the various departments of public health. Proper administration required a medical officer and his sanitary staff, a bacteriologist, a chemist, and an engineer, all working cordially together to a common end. For the smaller districts such a staff could be secured by grouping. Could they expect effective action if the medical officer was a

local practitioner who derived his livelihood by the goodwill of the local landlord?

Prof. Hewlett also denounced the way in which chemists were taking upon themselves the bacteriological examination of pathological material, and emphatically asserted that disease problems should be dealt with only by medical men. He also advocated that a course of biology should be obligatory for candidates for the associateship of the Institute of Chemistry taking the subject of biological chemistry.

An interesting discussion, opened by Dr. Newman, of Finsbury, was on the possibility of establishing a bacteriological standard of purity of milk. Dr. Newman suggested the following standards:—(a) not more than 24–25 degrees of total acidity at the time of sale, 1 degree being equivalent to 1 c.c. of deci-normal NaOH solution; (b) not an excess of pus or blood; (c) no *B. coli, B. enteritidis,* or *B. enteritidis sporogenes*; (d) non-virulent to guinea-pigs. All the speakers, including Dr. Allan Macfadyen, Prof. Kenwood, Dr. Savage, Colonel Firth, Mr. Revis and others, agreed that there was little possibility at present of fixing a standard, and Dr. Newman's suggestions did not obtain general acceptance.

Another discussion, on the relative efficiency of chemical and bacteriological methods for the examination of sewage effluents, was opened by Mr. Dibden and by Dr. Savage. There was a general agreement that chemical methods gave a better indication of proper purification than bacteriological ones, though, of course, bacteriological methods alone were of service in detecting species of micro-organisms.

Lieut. Nesfield, I.M.S., gave an interesting demonstration of a method devised by him for the sterilisation of drinking water during a campaign. He had found that chlorine in the proportion of 2 grams per 100 gallons acting for five minutes effectually destroyed the organisms of cholera, typhoid, and dysentery. His method consisted in carrying iron bottles of liquid chlorine, from which, by means of a valve, the requisite amount was liberated into the water. After five minutes a powder of sodium sulphite (2·2 grams) was added to the water, from which a double decomposition ensued, and the water was rendered absolutely tasteless. For the soldier on the march another method was devised, so that he could sterilise for himself a gallon of water. This consisted in adding to the vessel of water a tablet containing iodide and iodate of sodium. This resulted in the liberation of free iodine in the water, which acted in five minutes as an efficient germicide, and was then "killed," so that the water was rendered potable, by the addition of another tablet of sodium sulphite. In both processes the quantities of reagents employed are so small as to have no effect on the human economy; the methods are rapid, and the reagents, &c., portable.

ECLIPSE SHADOW BANDS.

ONE of the most peculiar appearances attending a total eclipse of the sun is that generally known as the "shadow bands." They are long dark bands, separated by white spaces, which are seen on the ground or sides of buildings just before and just after the total phase of an eclipse, moving rapidly. It is probable that they are not real bands, but are composed of dark patches which seem to the eye to make long bands. Their cause is not yet clearly known, as the observations in former eclipses are quite discordant. The undersigned is very desirous of obtaining observations of them at various stations along the line of totality, especially at places near the edge of the shadow, in order to compare with similar observations made by himself and others. The observations require no special instruments, and can be made by any careful person. Information is desired upon the following points:—(1) the direction in which the bands lie; (2) the direction in which they move; (3) the velocity with which they move; (4) the width of the bands; and (5) their distance apart. All of these are likely to be different before and after the total phase, so that two sets of observations are needed. The following suggestions are compiled from various sources.

Spread a white cloth or piece of canvas upon the ground in any convenient open space. It is well to spread *two* cloths or pieces of canvas, one to be used before, the other after, the total phase. Let each observer be furnished with several sticks, 4 feet to 6 feet long.

About three minutes before the time of totality, let the observer stand near the cloth with his back to the sun and watch the cloth intently. If bands or dark patches are seen, place one stick down in the direction in which they lie; after this is done place a second stick in the direction in which they are moving. Both of these operations should be done deliberately, not hurriedly, and the sticks left in position.

During the total phase the observer is free to enjoy the scene or make other observations, but it may be well to note if any bands can be seen during totality, as some have asserted.

At the close of totality the observer should be at the second cloth, or at another part of the single cloth (if he uses but one), and should repeat the observations made before totality, placing one stick down in the direction in which the bands lie, and another in the direction in which they move.

It will be seen that four sticks are needed for these observations. If two persons make the records, one should confine his attention to the direction in which the bands lie, the other to the direction in which they move. The bands are likely to be somewhat faint and poorly defined, so that extreme accuracy may not be possible.

The sticks should not be disturbed until after the eclipse, when their direction should be determined with as much care as possible, either by a compass or, still better, by a surveyor's theodolite if one is available. If neither compass nor theodolite is at hand, an estimate of the directions should be made.

The velocity with which the bands travel is more difficult to determine. The estimates vary from the speed of a man running to that of an express train. Several methods may be suggested:—

(1) Let two persons work together, one having a watch with the seconds marked on the face. Let him mark time by calling out each second. The number of the second is not important, but a simple sound to mark the seconds is sufficient. Let the other observer watch the bands and see how many he can count per second.

(2) With one observer marking time as before, let the second observer note how many seconds elapse while a band is passing between two objects the distance apart of which is known.

(3) Let a person run a short distance with the bands and see if he can keep up with them. If not, let him estimate how much faster the bands are moving than he can run.

(4) A mere guess at the speed is of some value.

The width of the bands and their distance apart can best be determined upon the cloths mentioned above, and it will add to the accuracy of the estimates if the cloths are divided by seams or in some other way into strips of known width. A carpenter's rule will aid the observer in making the estimates. The bands will probably be several inches wide and separated by spaces the width of which is the same or greater.

If the observer notices any other point connected with the bands, such as their colour, whether they are straight or wavy, whether they are continuous bands or made up of dark patches, whether they flicker or not, the information will be valuable. Still more valuable would be photographs of the bands as they pass over the ground or the side of a building or wall.

It is earnestly requested that anyone who will kindly attempt the above, either in whole or in part, will send his records to the undersigned. If for any reason the observation seems unsatisfactory, either because the bands were not as distinct as expected, or for any other reason, or if the record is only fragmentary, it will still be of value. The report should consist of a statement of the methods employed by the observer or observers in making the observations, and the results obtained, with any

remarks upon the subject or upon other phenomena noted at the time of the eclipse. A. LAWRENCE ROTCH.

Blue Hill Observatory, Hyde Park, Mass., U.S.A.

The observations may be summarised as follows:—

OBSERVATIONS OF SHADOW BANDS, AUGUST 30, 1905.

Place ....

(Situation and altitude)

Observers ....

....

	Before totality	After totality
1. Direction of bands,	....	....
2. Direction of motion,	....	....
3. Velocity,	....	....
4. Width of bands,	....	....
5. Distance apart,	....	....

Remarks:

Direction of the wind before totality....................., after totality....................., and direction from which upper clouds (if any) came.....................

THE LATENT IMAGE.[1]

MY inclination has led me, in spite of a lively dread of incurring a charge of presumption, to address you principally on that profound and most subtle question, the nature and mode of formation of the photographic image. I am impelled to do so, not only because the subject is full of fascination and hopefulness, but because the wide topics of photographic methods or photographic applications would be quite unfittingly handled by the president you have chosen.

I would first direct your attention to Sir James Dewar's remarkable result that the photographic plate retains considerable power of forming the latent image at temperatures approaching the absolute zero—a result which, as I submit, compels us to regard the fundamental effects progressing in the film under the stimulus of light undulations as other than those of a purely chemical nature. But few, if any, instances of chemical combination or decomposition are known at so low a temperature. Purely chemical actions cease, indeed, at far higher temperatures, fluorine being among the few bodies which still show chemical activity at the comparatively elevated temperature of $-180°$ C. In short, this result of Sir James Dewar's suggests that we must seek for the foundations of photographic action in some physical or intra-atomic effect which, as in the case of radio-activity or fluorescence, is not restricted to intervals of temperature over which active molecular *vis viva* prevails. It compels us to regard with doubt the *rôle* of oxidation or other chemical action as essential, but rather points to the view that such effects must be secondary or subsidiary. We feel, in a word, that we must turn for guidance to some purely photo-physical effect.

Here, in the first place, we naturally recall the views of Mr. Bose. This physicist would refer the formation of the image to a strain of the bromide of silver molecule under the electric force in the light wave, converting it into what might be regarded as an allotropic modification of the normal bromide which subsequently responds specially to the attack of the developer. The function of the sensitiser, according to this view, is to retard the recovery from strain. Bose obtained many suggestive parallels between the strain phenomena he was able to observe in silver and other substances under electromagnetic radiation and the behaviour of the photographic plate when subjected to long-continued exposure to light.

This theory, whatever it may have to recommend it, can hardly be regarded as offering a fundamental explanation. In the first place, we are left in the dark as to what the strain may be. It may mean many and various things. We know nothing as to the inner mechanism of its effects upon subsequent chemical actions—or at least we cannot correlate it with what is known of the physics of chemical activity. Finally, as will be seen later, it is hardly adequate to account for the varying degrees of stability which may apparently characterise the latent image. Still, there is much in Mr. Bose's work deserving of careful consideration. He has by no means exhausted the line of investigation he has originated.

Another theory has doubtless been in the minds of many. I have said we must seek guidance in some photo-physical phenomenon. There is one such which preeminently connects light and chemical phenomena through the intermediary of the effects of the former upon a component part of the atom. I refer to the phenomena of photo-electricity.

It was ascertained by Hertz and his immediate successors that light has a remarkable power of discharging negative electrification from the surface of bodies—especially from certain substances. For long no explanation of the cause of this appeared. But the electron—the ubiquitous electron—is now known with considerable certainty to be responsible. The effect of the electric force in the light wave is to direct or assist the electrons contained in the substance to escape from the surface of the body. Each electron carries away a very small charge of negative electrification. If, then, a body is originally charged negatively, it will be gradually discharged by this convective process. If it is not charged to start with, the electrons will still be liberated at the surface of the body, and this will acquire a positive charge. If the body is positively charged at first, we cannot discharge it by illumination.

It would be superfluous for me to speak here of the nature of electrons or of the various modes in which their presence may be detected. Suffice it to say, in further connection with the Hertz effect, that when projected among gaseous molecules the electron soon attaches itself to one of these. In other words, it ionises a molecule of the gas or confers its electric charge upon it. The gaseous molecule may even be itself disrupted by impact of the electron if this is moving fast enough and left bereft of an electron.

We must note that such ionisation may be regarded as conferring potential chemical properties upon the molecules of the gas and upon the substance whence the electrons are derived. Similar ionisation under electric forces enters, as we now believe, into all the chemical effects progressing in the galvanic cell, and, indeed, generally in ionised solutants.

An experiment will best illustrate the principles I wish to remind you of. A clean aluminium plate, carefully insulated by a sulphur support, is faced by a sheet of copper-wire-gauze placed a couple of centimetres away from it. The gauze is maintained at a high positive potential by this dry pile. A sensitive gold-leaf electroscope is attached to the aluminium plate, and its image thrown upon the screen. I now turn the light from this arc lamp upon the wire gauze, through which it in part passes and shines upon the aluminium plate. The electroscope at once charges up rapidly. There is a liberation of negative electrons at the surface of the aluminium; these, under the attraction of the positive body, are rapidly removed as ions, and the electroscope charges up positively.

Again, if I simply electrify negatively this aluminium plate so that the leaves of the attached electroscope diverge widely, and now expose it to the rays from the arc lamp, the charge, as you see, is very rapidly dissipated. With positive electrification of the aluminium there is no effect attendant on the illumination.

Thus from the work of Hertz and his successors we know that light, and more generally what we call actinic light, is an effective means of freeing the electron from certain substances. In short, our photographic agent, light, has the power of evoking from certain substances the electron which is so potent a factor in most, if not in all, chemical effects. I have not time here to refer to the work of Elster and Geitel whereby they have shown that this action is to be traced to the electric force in the light wave, but must turn to the probable bearing of this phenomenon on the familiar facts of photography. I assume that the experiment I have shown you is the most fundamental photographic experiment which it is now in our power to make.

[1] Address to the Photographic Convention of the United Kingdom, 1905. By J. Joly, F.R.S.

We must first ask from what substances can light liberate the electron. There are many—metals as well as non-metals and liquids. It is a very general phenomenon, and must operate widely throughout nature. But what chiefly concerns the present consideration is the fact that the haloid salts of silver are vigorously photo-electric, and, it is suggested, possess, according to Schmidt, an activity in the descending order bromide, chloride, iodide. This is, in other words, their order of activity as ionisers (under the proper conditions) when exposed to ultra-violet light. Photographers will recognise that this is also the order of their photographic sensitiveness.

Another class of bodies also concerns our subject:—the special sensitisers used by the photographer to modify the spectral distribution of sensibility of the haloid salts, *e.g.* eosine, fuchsine, cyanine. These again are electron-producers under light stimulus. Now it has been shown by Stoletow, Hallwachs, and Elster and Geitel that there is an intimate connection between photo-electric activity and the absorption of light by the substance, and, indeed, that the particular wave-lengths absorbed by the substance are those which are effective in liberating the electrons. Thus we have strong reason for believing that the vigorous photo-electric activity displayed by the special sensitisers must be dependent upon their colour absorption. You will recognise that this is just the connection between their photographic effects and their behaviour towards light.

There is yet another suggestive parallel. I referred to the observation of Sir James Dewar as to the continued sensitiveness of the photographic film at the lowest attained extremes of temperature, and drew the inference that the fundamental photographic action must be of intra-atomic nature, and not dependent upon the *vis viva* of the molecule or atom. In then seeking the origin of photographic action in photo-electric phenomena we naturally ask, Are these latter phenomena also traceable down to low temperatures? If they are, we are entitled to look upon this fact as a qualifying characteristic or as another link in the chain of evidence connecting photographic with photo-electric activity.

I have quite recently, with the aid of liquid air kindly supplied to me by Mr. Moss, and made in the laboratory of this society, tested the photo-sensibility of aluminium and also of silver bromide down to temperatures approaching that of the liquid air. The mode of observation is essentially that of Schmidt—what he terms his static method. The substance undergoing observation is, however, contained at the bottom of a thin copper tube, 5 cm. in diameter, which is immersed to a depth of about 10 cm. in liquid air. The tube is closed above by a paraffin stopper which carries a thin quartz window as well as the sulphur tubes through which the connections pass. The air within is very carefully dried by phosphorus pentoxide before the experiment. The arc light was used as source of illumination. It was found that a vigorous photo-electric effect continued in the case of the clean aluminium. In the case of the silver bromide a distinct photo-electric effect was still observed. I have not had leisure to make, as yet, any trustworthy estimate of the percentage effect at this temperature in the case of either substance. Nor have I determined the temperature accurately. The latter may be taken as roughly about $-150°$ C.

Sir James Dewar's actual measurements afforded twenty per cent. of the normal photographic effect at $-180°$ C. and ten per cent. at the temperature of $-252°.5$ C.

With this much to go upon, and the important additional fact that the electronic discharge—as from the X-ray tube or from radium—generates the latent image, I think we are fully entitled to suggest as a legitimate lead to experiment the hypothesis that the beginnings of photographic action involve an electronic discharge from the light sensitive molecule; in other words that the latent image is built up of ionised atoms or molecules the result of the photo-electric effect on the illuminated silver haloid, upon which ionised atoms the chemical effects of the developer are subsequently directed. It may be that the liberated electrons ionise molecules not directly affected, or it may be that in their liberation they disrupt complex molecules built up in the ripening of the emulsion. With the amount we have to go upon we cannot venture to particularise. It will be said that such an action must be in part of the nature of a chemical effect. This must be admitted, and, in so far as the re-arrangement of molecular fabrics is involved, the result will doubtless be controlled by temperature conditions. The facts observed by Sir James Dewar support this. But there is involved a fundamental process—the liberation of the electron by the electric force in the light wave, which is a physical effect, and which, upon the hypothesis of its reality as a factor in forming the latent image, appears to explain completely the outstanding photographic sensitiveness of the film at temperatures far below those at which chemical actions in general cease.

Again, we may assume that the electron-producing power of the special sensitiser or dye for the particular ray it absorbs is responsible, or responsible in part, for the special sensitiveness it confers upon the film. Sir Wm. Abney has shown that these sensitisers are active even if laid on as a varnish on the sensitive surface and removed before development. It must be remembered, however, that at temperatures of about $-50°$ these sensitisers lose much of their influence on the film. [See a paper by me read before the convention in 1894.]

It appears to me that on these views the curious phenomenon of recurrent reversals does not present a problem hopeless of explanation. The process of photo-ionisation constituting the latent image, where the ion is probably not immediately neutralised by chemical combination, presents features akin to the charging of a capacity—say a leyden jar. There may be a rising potential between the groups of ions until ultimately a point is attained when there is a spontaneous neutralisation. I may observe that the phenomena of reversal appear to indicate that the change upon the silver bromide molecule, whatever be its nature, is one of gradually increasing intensity, and finally attains a maximum when a return to the original condition occurs. The maximum is the point of most intense developable image. It is probable that the sensitiser—in this case the gelatin in which the bromide of silver is immersed—plays a part in the conditions of stability which are involved.

Of great interest in all our considerations and theories is the recent work of Prof. Wood on photographic reversal. The result of this work is—as I take it—to show that the stability of the latent image may be very various according to the mode of its formation. Thus it appears that the sort of latent effect which is produced by pressure or friction is the least stable of any. This may be reversed or wiped out by the application of any other known form of photographic stimulus. Thus an exposure to X-rays will obliterate it, or a very brief exposure to light. The latent image arising from X-rays is next in order of increasing stability. Light action will remove this. Third in order is a very brief light-shock or sudden flash. This cannot be reversed by any of the foregoing modes of stimulation, but a long-continued undulatory stimulus, as from lamp-light, will reverse it. Last and most stable of all is the gradually built-up configuration due to long-continued light exposure. This can only be reversed by overdoing it according to the known facts of recurrent reversal. Prof. Wood takes occasion to remark that these phenomena are in bad agreement with the strain theory of Mr. Bose. We have, in fact, but the one resource—the allotropic modification of the haloid—whereby to explain all these orders of stability. It appears to me that the elasticity of the electronic theory is greater. The state of the ionised system may be very various according as it arises from continued rhythmic effects or from unorganised shocks. The ionisation due to X-rays or to friction will probably be quite unorganised, that due to light more or less stable according to the gradual and gentle nature of the forces at work. I think we are entitled to conclude that on the whole there is nothing in Prof. Wood's beautiful experiments opposed to the photo-electric origin of photographic effects, but that they rather fall in with what might be anticipated.

When we look for further support to the views I have laid before you we are confronted with many difficulties. I have not as yet detected any electronic discharge from the film under light stimulus. This may be due to my defective experiments, or to a fact noted by Elster and Geitel concerning the photo-electric properties of gelatin.

They obtained a vigorous effect from Balmain's luminous paint, but when this was mixed in gelatin there was no external effect. Schmidt's results as to the continuance of photo-electric activity when bodies in general are dissolved in each other lead us to believe that an actual conservative property of the medium and not an effect of this on the luminous paint is here involved. This conservative effect of the gelatin may be concerned with its efficacy as a sensitiser.

In the views I have laid before you I have endeavoured to show that the recent addition to our knowledge of the electron as an entity taking part in many physical and chemical effects may be availed of, and should be kept in sight, in seeking an explanation of the mode of origin of the latent image.

GLACIAL STUDIES IN CANADA.

DR. WILLIAM H. SHERZER has published in the *Smithsonian Miscellaneous Collections* (pp. 453–496) a handsomely illustrated preliminary report entitled "Glacial Studies in the Canadian Rockies and Selkirks." The five glaciers selected are conveniently located in Alberta and British Columbia, and the line of the Canadian Pacific Railway passes near them. Observations have been made on the rate of motion of the Victoria Glacier, which is as low as about 52 feet a year, and on the lowering of its surface by ablation. The front of this glacier shows a shearing movement of one layer over another, as was tested by the pushing forward of iron spikes driven into an upper and a lower stratum. The right lateral moraine receives a certain amount of ground-moraine or subglacial material from a hanging glacier on Mount Lefroy, which breaks away in avalanches on to the main Victoria flow. This incident, which is well illustrated, serves to warn us from assuming that all subglacial material at a glacier's edge results from plucking action on the wall or floor in contact with the local ice.

A brief but useful discussion of "dirt-bands" follows, in which three types are distinguished. Layers of the glacier may vary in the percentage of foreign matter contained in them, and these stratified dirt-bands may be too thick to represent mere temporary variations in snowfall, and probably then correspond with short cycles of variation in the "activity of the glacier-making agencies." A second type of dirt-band is that described by Forbes, conspicuous at a distance, and transverse to the length of the ice-stream; the author traces this appearance to the alternation of depressions and ridges, stones and mud becoming washed into the former, and producing the dark bands, which may be bent forward in the central region as the glacier flows. The explanation given is adopted from Tyndall. The greater rapidity of motion in summer produces a crevasse, or a close-set series of crevasses, where there is a marked increase in the drop of the valley-floor. The sun melts out a depression along the line of the crevasse or crevasses, which remains although the fracture heals. In winter, owing to the slower motion, the ice adapts itself better to its inclines, and the few crevasses that are formed are not emphasised at the top by melting. Hence each dirt-band represents a summer season, and the interval a winter one. The third type of dirt-band depends on the greater resistance to melting offered by blue solid ice, as compared with the intervening layers of vesicular ice. The latter, therefore, form depressions on the melting of the mass, in which detritus gathers, as in the case of the far coarser dirt-bands of the second type. Dr. Sherzer proposes to call a band of the first type a "dirt-zone," and of the third type a "dirt-stripe." The well known blue bands are shown later to have no relation to stratification, and we are left in ignorance as to their origin.

On the lower Lefroy Glacier "ice-dykes" are noted, true mineral veins, as it were, with ice-crystals deposited on their walls and meeting from opposite sides along the central plane. These represent crevasses, which have been healed by the freezing of the water that at one time filled them.

The author's examination of the surfaces of junction of glacier-grains shows that melting opens up a network of delicate tube-like capillaries, which are here photographed —we presume on a natural scale—both before and after injection with potassium permanganate. As melting proceeds, this network disappears, apparently by a general coarsening of the hollows developed between adjacent grains.

FIG. 1.—Formation of Forbes's "dirt-bands," Deville Glacier, Selkirks. From Summit Mt. Fox, looking Eastward. Photographed by Arthur O. Wheeler, 1902. Canadian Topographic Survey.

We shall hope to hear more of the author's views on "block-moraines," since we cannot help thinking that such phenomena are far too common for the invocation of earthquake-action as a cause. The double moraine below Lough Coumshingaun, in the county of Waterford, would seem to come into this category; and in that case the jointed nature of the rocks higher up the mountain accounts for the preponderance of huge and angular blocks. The discovery of ice-cores within the steep lateral embankments of the Asulkan Glacier raises the question of such embankments in general; and here again we hope for further details. The illustrations, one of which is here reproduced, are richly varied, and are of equal value to the geographer and the geologist.

GRENVILLE A. J. COLE.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—It has been announced that the chemical fellowship at Magdalen College, to which an election will be made next term, is open to all persons who have qualified for the degree of B.A. at Oxford, and are not in the receipt of an income of more than 300*l*. per annum. The examination will begin on October 3, and will be mainly in the subjects recognised in the honour school of chemistry. Any candidate may submit any dissertations or papers written by him or any evidence of research work done by him.

THE council of the University of Liverpool has, on the recommendation of the university senate, determined to institute a university lectureship in experimental psychology.

PROF. W. H. WATKINSON, at present professor of engineering in the Glasgow and West of Scotland Technical College, has been appointed to the Harrison chair of engineering in the University of Liverpool formerly filled by Prof. Hele-Shaw, F.R.S.

THE governors of the Merchant Venturers' Technical College, Bristol, have decided to award annually to the most suitable candidate who, being a member of the college, has graduated in science at the University of London or gained a similar distinction, a research scholarship of the value of 50*l*., tenable at the college for one year. The research scholar will be required to undertake some research work either in the department of applied chemistry or in that of engineering. The governors will defray the cost of the apparatus and materials needed for the prosecution of such work.

THE detailed regulations and syllabus for the preliminary examination for the certificate, which will in 1907 take the place of the King's scholarship examination, which pupil teachers have been in the habit of taking at the end of their apprenticeship, have been issued as an appendix to the regulations for the instruction and training of pupil teachers, 1905. The distribution of subjects in the re-cast examination has received the careful consideration of the Board of Education. In order to be successful a candidate must pass a test in the important subjects, including composition and arithmetic, which form part i. of the examination, and also show a reasonable degree of proficiency in English, history, and geography. To quote the circular which has been distributed to local education authorities, training colleges, and pupil teacher centres:—"To these the Board would gladly have added elementary science. They have, however, refrained at present from doing so because, except in fully equipped secondary schools and pupil teacher centres, it is not always possible for candidates to obtain the necessary instruction in practical scientific work, while they are convinced that instruction in science which does not include practical work is of very little value." It is satisfactory to record this frank admission by the Board of Education of the great importance of including elementary science in every scheme of education, whether elementary or secondary. It is to be hoped that every effort will be made by the Board to bring about increased facilities for instruction in elementary science in all schools under their jurisdiction, and not only in those from which pupil teachers proceed to the training college. It is not too much to say that no system of training designed to provide efficient elementary school teachers will prove thoroughly satisfactory which does not subject the teacher in training to a course of practical work in science. Even if it is considered necessary at present to make science an optional subject in this preliminary examination for the certificate, every effort should be made so to improve the equipment of the schools that elementary science may be made obligatory for all candidates at an early date.

A TREASURY Minute upon the recommendations of the university colleges committee has been issued as a Parliamentary paper. The consideration of the final report of Mr. Haldane's committee on the allocation of the grant in aid to university colleges is resumed. The recommendation of the establishment of a permanent committee to advise the Board of Treasury as to the distribution of the grant in aid is accepted, and an endeavour will be made in the autumn to constitute such a body, which will perform the duties hitherto undertaken by the quinquennial committee of inspection. Some of the colleges have pointed out that the intervention of such a committee may interfere unduly with their internal administration, but the Minute lays it down that the main functions of the committee will be to advise the Board of Treasury as to the kind of education which should be assisted out of the grant, and to satisfy themselves by inspection that the money is being properly applied. These objects can be obtained without any undue interference with the responsibility of the college authorities. Ninety per cent. of the grant is in the future to be allocated on the same general principles as have been adopted hitherto, and such sums as may be given will be secured to the colleges for at least five years. The balance of the grant will be reserved partly for special grants towards the provision of books and apparatus and partly for the encouragement of post-graduate work. The colleges will be expected to make proposals to the advisory committee as regards post-graduate work, showing the nature of the work it is desired to undertake and the assistance the college itself intends to contribute to the work. Parliament is being asked to vote 100,000*l*. for university colleges, and if this is agreed to 89,000*l*. will be distributed and 11,000*l*. reserved for allocation in March next. The amount allotted to each college for the year 1905–6 will be as follows:—Manchester, 12,000*l*.; University College, London, 10,000*l*.; Liverpool, 10,000*l*.; Birmingham, 9000*l*.; Leeds, 8000*l*.; King's College, London, 7800*l*.; Newcastle-on-Tyne, 6000*l*.; Nottingham, 5800*l*.; Sheffield, 4600*l*.; Bedford College, London, 4000*l*.; Bristol, 4000*l*.; Reading, 3400*l*.; Southampton, 3400*l*.; Dundee, 1000*l*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—"Explosions of Mixtures of Coal-Gas and Air in a Closed Vessel." By L. **Bairstow** and A. D. **Alexander.**

Summary.

Mixtures of coal-gas and air are not inflammable until the volume of coal-gas is greater than one-seventeenth of the combined volumes. Only a very small fraction of the gas then burns, the amount burnt rapidly increasing with increased richness of the mixture until the coal-gas is one-twelfth of the total volume. The least inflammable of the constituents then burns, and combustion becomes and remains complete so long as air is in excess. In these latter cases it is still probable that the constituents burn successively and not simultaneously.

The hypothesis of a specific heat increasing with temperature is not supported by direct experiment, and cannot be proved by any work on the pressures produced by explosion, the authors believing that a proof would require the measurement of temperature.

Direct experiments by Deville at temperatures below 1400° C. have shown that both steam and carbon dioxide are partially decomposed, and this dissociation is therefore taken by us as the sole explanation of the difference between the pressures calculated for explosions in a closed vessel and those actually obtained.

PARIS.

Academy of Sciences, July 17.—M. Troost in the chair.—On a new method of direct determination of refraction at all heights: M. **Lœwy.** The author describes and explains the theory of his new method by which atmospheric refraction can be measured by the use of a prism the refracting faces of which are at an angle of 45°.—On an apparatus for producing artificial eclipses of the sun: Ch. **André.** By the use of such apparatus many theoretical points can be determined in a way not otherwise possible.—On the infinitesimal properties of non-Eucildean space: C. **Guichard.**—On the distribution of sugary substances in blood between the plasma and the corpuscles: R. **Lépine** and M. **Boulud.** By eliminating certain errors due to glycolysis, the authors find for the corpuscles 22 per cent., and for the serum barely 4 per cent. of sugar.—On the evaluation of errors in the approximate integration

of differential equations: Émile **Cotton.**—A contribution to the study of liquid dielectrics: P. Gourée **de Villemontée.** The author's experiments were made with reference to the influence of the duration of charge, and the electric state of the mass after discharge. The results show that the propagation of electric charges across petrol and paraffin is comparable with that observed in crystalline dielectrics.—Experimental researches on the effect of membranes in liquid chains: M. **Chanoz.** The electromotive force developed by the chain of the general nature $MR|H_2O|MR$ depends for sign and intensity upon the nature of the membrane, the nature and concentration of the salt solution MR, and the relative position of the membranes to the liquids.—On fluorescence: C. **Camichel.** Further experiments on the coefficient of absorption in uranium glass when fluorescence is excited.—On the velocity of crystallisation from supersaturated solutions: Charles **Leenhardt.**—On the preparation of binary compounds of metals by means of heating with aluminium: C. **Matignon** and R. **Trannoy.** The great reducing power of aluminium has been utilised to prepare a considerable number of metallic phosphides, arsenides, silicides, and borides.—On the reduction of thorium oxide by amorphous boron, and the preparation of two borides of thorium: Binet **du Jassonneux.**—On the action of chloroacetic esters on the halogen magnesium derivatives of orthotoluidine: F. **Bodroux.**—On the action of ethylamine and *iso*butylamine on cæsium: E. **Rengade.** When ethylamine is condensed on perfectly pure cæsium a blue colour appears in the liquid which does not occur with sodium or calcium. In time the metal becomes a mercury-like substance which evolves gas readily, and is considered by the author to be cæsium-ethyl-ammonium.—Attempts at reduction in the dinitro-diphenyl-methane series of compounds: H. **Duval.**—On the condensation of chloral with aromatic hydrocarbons under the influence of aluminium chloride: Adolphe **Dinesmann.** By the action of chloral on benzene the author obtains in the given conditions excellent yields of trichloro-methyl-phenyl-carbinol,

$$C_6H_5—CHOH—CCl_3.$$

A similar condensation takes place with toluene, paraxylene, and anisol.—On 3:3-dimethyl-butyro-lactone: G. **Blanc.**—On the action of acetylene tetrabromide and aluminium chloride on toluene: James **Lavaux.**—On gentio-picrine: Georges **Tanret.**—On coffees without caffeine: Gabriel **Bertrand.** *Coffea Humblotiana* is noteworthy as containing barely a trace of the alkaloid.—On the development of green plants in light, in the complete absence of carbon dioxide, and in an artificial soil containing amides: Jules **Lefèvre.** The presence of the amides enabled plants to find the carbon necessary for the synthesis of both protoplasm and tissues.—On two cases of grafting (*Ipomea purpurea* with *Quamoclit coccinea* and *Helianthus multiflorus* with *Helianthus annuus*): Lucien **Daniel.**—On the disinfectant properties of smokes; attempts at disinfection with the vapour evolved from burning sugar: A. **Trillat.**—On the identification of the skin of the American admiral Paul Jones, 113 years after his death: MM. **Capitan** and **Papillault.**—On the multiple affinities of the Hoplophoridæ: H. **Coutière.**—On a new exploration of the abyss of the Trou-de-Souci: E. A. **Martel.**—On the mineral constituents of the water supplying Paris: L. **Cayeux.**—The hailstorm of July 16: A. **Berget.** Hailstones were found to weigh as much as 70 grams.

NEW SOUTH WALES.

Linnean Society, May 31.—Mr. T. Steel, president, in the chair.—Notes on the Eucalypts of the Blue Mountains, N.S.W.: J. H. **Maiden** and R. H. **Cambage.** The authors enumerate twenty-seven species and one variety collected by them. One of these, for which they propose the name of *E. Moorei*, is new; it has hitherto been looked upon as a narrow-leaved variety of *E. stellulata*, Sieb., but the juvenile foliage, for example, is very different. The past year was a specially favourable season for natural seedlings of the above genus, and a number of them are described for the first time. Particular notice is devoted to the Blue Mountain form of *E. capitellata*, Sm. Attention is directed to three plants which cannot, in strictness, be referred to any existing species, and which are looked upon as possible hybrids. The Blue Mountains, with their ready accessibility to both plateaux and valleys, considerable range in elevation, and rich Eucalyptus flora, afford special facilities for a study of the genus.—Notes on the native flora of New South Wales, part iii.: R. H. **Cambage.** This paper refers to the flora of the country between Orange, Dubbo, and Gilgandra, and directs attention to the great change that takes place from climatic causes which are regulated by the change in altitude, the fall in the country from Orange to Gilgandra amounting to about 2000 feet. Although much of the true interior flora is to be found at the latter place, it is noted that a number of plants which are typical of the coastal vegetation are also growing there, and the reason may be traced to the fact that a large sandstone area, chiefly Triassic, extends from Sydney across the Blue Mountains, continuing in broken remnants past Gulgong towards Dubbo and Gilgandra; and many of those plants which are able to withstand the cold of the higher levels cross the mountains and continue on the similar geological formation out towards the western plains. Reference is also made to an interesting species of Acacia, known locally as Motherumbung, and having affinities with *A. Gnidium*, Benth., but which in the absence of full material has not yet been identified.—Descriptions of new species of Australian Coleoptera: H. J. **Carter.** Fourteen species are described as new. These are referable to three families and eight genera, namely:—fam. Tenebrionidæ, Pterohelæus, Encara, Menephilus, Otrintus, Adelium (five species), and Coripera (two species); fam. Œdemeridæ, Pseudolychus (two species); fam. Pediliidæ, Egestria.

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THURSDAY, AUGUST 3, 1905.

RECENT FRENCH MATHEMATICAL WORKS.

La Philosophie naturelle intégrale et les Rudiments des Sciences exactes. By Dr. A. Rist. Part i. Pp. vi+132. (Paris: A. Hermann, 1904.) Price 3.50 francs.

Étude sur le Développement des Méthodes géométriques. By Gaston Darboux. Pp. 34. (Paris: Gauthier-Villars, 1904.) Price 1.50 francs.

Sur le Développement de l'Analyse et ses Rapports avec diverses Sciences. By Émile Picard. Pp. 168. (Paris: Gauthier-Villars, 1905.) Price 3.50 francs.

Introduction à la Géométrie générale. By Georges Lechalas. Pp. ix+65. (Paris: Gauthier-Villars, 1904.) Price 1.50 francs.

Introduction à la Théorie des Fonctions d'une Variable. By Jules Tannery. Vol. i. Second edition. Pp. ix+422. (Paris: A. Hermann, 1904.)

Correspondance d'Hermite et de Stieltjes. Edited by B. Baillaud and H. Bourget. Vol. i. Pp. xxi+477. (Paris: Gauthier-Villars, 1905.) Price 16 francs.

THE part which France has played in the development of modern mathematical methods, especially in connection with geometry and analysis, is well known to every mathematician. Of recent years, however, the trend of mathematical thought has considerably changed in every country, and while France has produced a large school of writers on the philosophy of mathematics, it is in the opinion of the present reviewer doubtful whether this school can forge more than a very small link in the chain of mathematical development. The doubts which arose in the minds of mathematicians regarding Euclid's eleventh axiom led to the new science of non-Euclidean geometry, but it was not so much the mere philosophical speculations concerning the axiom itself as the examination of the consequences of making alternative assumptions that led to substantial progress being made. The discovery that we cannot be sure that two and two make four except as the result of experience is undoubtedly of importance, but it is in the development of the consequences of a more extended hypothesis, of which this one is or is not a particular case, that substantial progress must be sought.

Dr. Rist's book may be taken as affording a good example of the kind of philosophical speculations which arise when we try to analyse the why and wherefore of the various processes and operations occurring in even so elementary a subject as arithmetic. It contains chapters on the prolegomena of both geometry and arithmetic, but it is in connection with the latter subject that the discussion is most extended. The mere act of *counting* forms the subject of a number of paragraphs of which the general character may be fairly understood from an enunciation of the headings:—"The number considered as the result of an act," "What do we count?" "Why do we count?" "The different modes of counting." From counting the author proceeds to *calculation,* and in the following chapter gives a detailed discussion of the various processes and symbols involved in the two operations of addition and subtraction. One would naturally expect multiplication and division to be treated in the same way, but instead, Dr. Rist sets out an alternative method of approaching this study, and this first volume closes with a chapter showing how numbers serve for evaluations.

The book seems to appeal more particularly to elementary teachers who only possess a rudimentary training in algebra and geometry, for there is little or nothing in it which assumes more than an elementary knowledge of these subjects. The highly trained mathematician would hardly benefit by reading such a book, as he would probably have already formed ideas of his own on the subject, and in all likelihood would consider the treatment to be unsatisfactory in a good many respects.

Of the useful purpose that can be served by popular addresses containing the survey of wide regions of mathematical thought we have two excellent examples before us. America, with that spirit of internationalism the absence of which from our islands is so greatly to be regretted, loses no chance of picking the brains of the world's greatest mathematicians, irrespective of nationality. Prof. Darboux's pamphlet and the second part of Prof. Picard's contain the substance of addresses delivered at St. Louis last year. The two addresses are to a great extent complementary. Prof. Darboux treats of the development of geometry during the nineteenth century, and Prof. Picard gives a historical account, similar in character, of the development of analysis, with especial reference to its relations with geometry, mechanics, and mathematical physics. Prof. Picard's St. Louis address also forms a sequel to the series of three lectures delivered by him in 1899 at Clark University which form the first part of the same book. The first of these deals with the gradual extension of the meaning attached to the word "function" during the last century, and the numerous new regions of mathematical thought opened up by this development. The second deals with the theory of differential equations, and the third with analytic and certain other functions. In concluding, M. Picard advises students not to specialise in mathematics at too early a stage, but to endeavour to form a general survey of different branches of the science first, and his lectures afford an excellent preliminary step towards the formation of such a survey in the case of analysis.

An English translation of M. Darboux's addresses has appeared in recent numbers of the *Mathematical Gazette.*

M. Lechalas's small volume in the series of "Actualités scientifiques" deals with Euclidean and non-Euclidean geometry. The subject is introduced by a chapter on Euclidean geometry of one, two, and three dimensions. The geometry of Riemann's space is deduced from the Euclidean geometry of four dimensions. That the properties of a Riemann plane and a Euclidean sphere are identical so long as only

the surface itself is concerned is admitted, but whether the Riemann space is identical with, or only analogous to, spherical space in a hyperspace of four dimensions remains a subject of controversy between the author of the book and M. Mansion. At any rate, M. Lechalas does not discuss space of positive curvature independently of its connection with four-dimensional Euclidean space, and accordingly the book contains only one more chapter devoted to the geometry of Lobatchefsky and Bolyaï. In this respect the treatment is analogous to that given in some books on conics where the properties of the ellipse are proved by three-dimensional methods (orthogonal projection) and those of the hyperbola by plane geometry. Whether this is the best plan is open to question; many mathematicians seem to prefer it, and an author cannot please everybody.

In his preface, which is printed in *italics*, M. Tannery fairly well defines the scope and object of his book. Although this is a second edition, it has been entirely re-written. It is primarily intended for readers who do not possess a very extended knowledge of mathematics. It covers mainly those portions of analysis which are commonly found in English text-books on higher algebra, viz. properties of irrational numbers, continued fractions, aggregates, convergency and divergency of series and of infinite products, the binomial theorem, the exponential and logarithmic series, and expansions of trigonometric functions treated without the aid of imaginaries. Finally, we have a chapter on derived functions containing applications of the formula

$$f(x+h)-f(x)=hf'(x+\theta h),$$

and an illustration of functions which have no differential coefficient. The subject-matter may all be included under the heading "functions of real variables treated algebraically," as M. Tannery has avoided the use of geometrical methods in the present volume. A second volume is promised dealing with functions of complex variables, in which geometrical methods are to be freely used.

The treatment is clear and full, and the book gives the impression of being as good an exposition of the subject as could well be written on the lines laid down by the author. It does not profess to give historical or bibliographical information, for which the reader is referred to the "Mathematical Encyclopædia," of which the French edition is now coming out.

An interesting insight into the thoughts of two eminent mathematicians is afforded by the first volume of correspondence between Hermite and Stieltjes, covering the period 1882–1889. The intimacy seems to have arisen in 1882, out of a letter addressed by Stieltjes to Hermite dealing with a theorem of M. Tisserand relating to the expansion of the disturbing force when the mutual inclination of two orbits is considerable. The subject-matter of this letter (which is missing from the collection) was published in the *Comptes rendus* for November 13, 1882.

At this time Thomas Jean Stieltjes was attached to the Observatory of Leyden, and the influence of Hermite doubtless accounts in large measure for his activity in mathematical research during the years which followed, culminating in his migration to France in 1885, after his failure to obtain a mathematical chair in his own country.

A noteworthy feature of Stieltjes's work is his partiality for simple arithmetical tests of general theorems. The value of his examinations of numerical details must have been enormous to a man of Hermite's calibre. It seems as if Hermite in many cases furnished the ideas which Stieltjes elaborated and extended. It was not with Stieltjes alone that Hermite carried on an extensive correspondence, for he was evidently fond of writing letters, and even many of his contributions to journals appeared in epistolary form. But among his various correspondents Stieltjes played a prominent part, and it was Hermite's own wish that the letters of his colleague should be published after the premature death of the latter in 1894. One thing is unfortunately wanting. Hermite was to have written an introduction, but he did not live to do so. In its place we have a preface by M. Picard and a biographical notice by M. H. Bourget, who, in conjunction with M. Baillaud, were colleagues of Stieltjes in the University of Toulouse from 1886 until his death, and who have jointly edited the present volume.

It would be difficult to give a general summary of the subject-matter of this correspondence, which deals with continued fractions, hypergeometric series, Legendre's functions, semi-convergent series, and, indeed, analysis generally. Portraits of Hermite and Stieltjes complete the volume. There is a certain brightness and freshness about the way one of the two mathematicians writes to the other announcing some new result and the second takes up the clue and develops it, and one can imagine the delight that the two kindred spirits must have had in working together.

While the volumes before us are widely different in character, it may be well to warn the busy reader, as has been done on previous occasions, that they all possess one objectionable feature in common. While the guillotine was originally invented in France, the modern instrument of that name has not been applied to its proper use on the pages of any one of the series, consequently readers, unless they are prepared to set up a private guillotine, are compelled to waste hours in hacking and jagging the leaves with a paper knife, producing a very untidy result.

G. H. B.

THE MUTATION THEORY OF THE ORIGIN OF SPECIES.

Species and Varieties: their Origin by Mutation. By Hugo de Vries. Edited by D. T. MacDougal. Pp. xviii+847. (London: Kegan Paul and Co., Ltd., 1905.)

AT the present time, when naturalists are beginning to turn again to the problem of the origin of species, this account of Prof. de Vries's theories and experiments is sure of a welcome, partly

as the most recent exposition of that naturalist's views and researches, and partly as the first account of them available in the English language.

It has been maintained by those who attack biological problems by methods by which they insist that they do not hope to account for anything, that it is idle to attempt to explain the phenomena of variation and heredity until they have been adequately described; and although it is certain that the danger of a too premature attempt to account for things is greater among those who use methods by which they believe the fundamental nature of the things will ultimately be revealed than it is among statistical evolutionists, it does not follow that it is better to adopt the second course on account of these (really not very dangerous) pitfalls in the first. Of the possibility of adopting it without falling into them at all Prof. de Vries's work is a rare example. The book before us consists of twenty-eight lectures delivered at the California University by Prof. de Vries, and prepared for the press by Mr. D. T. MacDougal. It will be of immense value to the student whose lack of knowledge of German renders "Die Mutationstheorie" a sealed book to him, as well as to the investigator; but two features of it, which result from the mode of its origin, render it a less valuable work than "Die Mutationstheorie." One of them, which affects the student and general reader, is the absence of illustrations; the other, which affects the investigator, is the absence of references, which is a real drawback in a book that puts into circulation the details of many unfamiliar and interesting breeding experiments.

Seeing that this book is likely, and intended, to appeal to the student, there is one feature of it which might have been different with advantage; and we believe the defect to be serious, because the general reader will notice it as little as he will deplore the absence of pictures much.

The publication of a book in which there is set forth for the student a new and profoundly important biological theory, and a collection of facts in support of it, seems to us to have been a most suitable opportunity for discarding that scientific jargon which is still believed to have a meaning by those who do not understand it, and still used by those who know that it means nothing. In the very first sentence it appears in its old vigour.

"Newton convinced his contemporaries that natural laws rule the whole universe. Lyell showed, by his principle of slow and gradual evolution, that natural laws have reigned since the beginning of time."

Of course Prof. de Vries and Mr. MacDougal know that natural laws do not really rule the universe, and that they have not reigned since the beginning of time, and that this latter expression stretches even poetical licence. But the general reader and student do not know this, and when they see this kind of statement scattered through scientific literature they can be pardoned for going away with the idea that there must be laws existing somewhere ruling and reigning and being obeyed, and that it is the business of the man of science to discover them.

A few examples from the body of the book will suffice. For instance, on p. 3, "If an origin by natural laws is conceded for the latter, it must, on this ground, be granted to the first also"; on p. 90, ". . . wild species, which obey the laws discussed in a previous lecture"; on p. 175, ". . . and liable to reversions by the ordinary laws of the splitting up of hybrids"; and on p. 547, "The physiological laws, however, which govern this process are only very imperfectly revealed by such a study."

We are perfectly aware that such expressions are continually to be found in the memoirs of men of science who in their other writings have exposed the meaninglessness of such phrases; but this only leads to the necessity of a stronger insistence on the desirableness of discarding them, in the conviction that the curious image of nature which such expressions call up would be less erroneous and more eradicable than it is now if they were never used.

The fact that entirely different things sometimes have the same name leads to the need for caution in the interpretation of another expression the meanings of which are about as numerous and as different as those of the term "law." The word regression in Prof. de Vries's book denotes a biological phenomenon of singular interest; but it must not be forgotten that it is also the name of a purely statistical conception. It is very necessary that these two significations should be kept absolutely distinct in the mind of the reader.

The book is, considering its bulk, very free from misprints; the few that occur do not lead to any difficulty, *e.g.* "begining" on p. 118, "hnudred" on p. 475, "of" for "on" in the last line of p. 560. There is one inconsistency of spelling; Macfarlane is spelt thus on pp. 21 and 268, and with a capital F on p. 255. We have some doubt as to which is the more correct, "morphologic" or "morphological," though we have none as to which is the more euphonious; but surely one or the other should be used throughout; yet on p. 141 we find "morphological" and on p. 144 "morphologic," and similarly on p. 144 "physiologic" and on p. 547 "physiological," on p. 709 "empiric" and on p. 733 "empirical."

We think that scant justice is done to the greatness of Mendel's work and to the conceptions based upon it which bid fair to put us on the track of accounting for some of the phenomena of heredity; and by confining Mendel's law to the description of the mutual properties of varieties only, the meaning and tendency of Mendelian investigation that is now being carried on seem to be missed. That Hurst can predict the difference between the result of mating two pairs of rabbits externally identical, by means of a knowledge of the difference between their gametic constitutions acquired by previous breeding from them, constitutes, it seems to us, the longest stride the study of heredity has made for some time past.

The zoologist who confines himself as strictly to the study of animals as Prof. de Vries does to that of plants will be disappointed if, trusting to the comprehensiveness of the title of the book, he expects to

find as much about the one half of living nature as about the other in it.

The most fruitful source of progress is a new way of looking at things, and such new points of view result in the destruction of old classifications and the need for new ones; in biology, investigators will soon cease to be classified according to the group of animals or plants with which they deal, but according to the particular phase of the problem of the "fundamental nature of living things" (which is the ultimate goal of biological inquiry) which interests them. In the study of heredity, for example, there is already a number of investigators who are as familiar with that phenomenon in the case of animals as in the case of plants. Nor does it seem reasonable to doubt that, by thus broadening the basis of material used by the investigator, the conclusions arrived at by him are likely to be less wide of the truth than they are apt to be if they are based on the result of experiment with a single animal or plant. The moral of this is, not that Prof. de Vries ought to have said something about animals in his book, but that the disappointed zoological reader ought to know something about plants for the sake of his work.

To bestow praise on any work of Prof. de Vries would be impertinent; to cite points of particular interest in the book is unnecessary, for it has already begun to form part of the indispensable equipment of the student of evolution in the broadest sense of that term. A. D.

ASPHALT PAVEMENTS.

The Modern Asphalt Pavement. By Clifford Richardson. Pp. vii+580. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 12*s.* 6*d.* net.

THIS is a book dealing with an important practical subject which up to the present time has not received much attention from writers of text-books. Asphalt pavements of various kinds are now so largely used that a text-book dealing with this subject has been a long-felt want.

The book is divided into sections, and the author has appended to the end of each chapter a brief summary of the matter dealt with, enabling the reader to determine quickly whether or not the chapter contains the information he is seeking for. The first section deals with the construction of the road base upon which the surface carrying the traffic is supported, and it is evident that Mr. Richardson is of opinion that the ideal base is hydraulic concrete. Between this base and the surface proper is interposed a binder, or intermediate, course; where the traffic is heavy, the best material for this is a layer of compact asphaltic concrete. The next section is concerned with the materials employed in making the asphalt surface mixture, and a detailed account is given of the sands used for this purpose and of their origin and physical characteristics. After a brief explanation and classification of the various hydrocarbons of which native bitumen is composed, the author describes the native bitumens which have so far been used in paving work.

In section iv. the technology of the paving industry is taken up; the preparation of the surface mixture is explained with the help of elaborate tables, and the theory which underlies the practical work is described; the author points out that an asphalt surface in order to be successful must resist both weathering and impact. The mechanical appliances used for combining the various materials into the surface mixture are described with diagrams.

Sections v. and vi. deal with the handling of the material in the street and with the hand-tools needed by the workmen, and in the latter section a description of an ingenious machine for impact tests is given. In section vii. there is a complete specification for an asphalt pavement; this will be found of great value to engineers who have to draw up specifications for work of this nature. Mr. Richardson points out that the popular idea as to the limiting gradient for an asphalt pavement is erroneous, and that in the eastern part of the United States, for example, a gradient of 8 per cent. on an asphalt road is not excessive. There is no doubt that asphalt has great advantages when compared with most of the other pavement materials; it is free from mud if properly washed down at regular intervals; unlike wood, it is practically non-absorbent; when kept in a clean condition it gives a good foothold for horses; tractive effort is considerably reduced, and even under heavy traffic asphalt wears remarkably well. Although the initial cost is heavy, still the cost of upkeep is lower than that for most of the other paving materials. The last section of the book, one of the most valuable, deals with the testing of the various materials used in asphalt pavement work; it gives a complete account of this necessary branch of the work, and data are given of the equipment required in a municipal laboratory where such testing work is carried out.

The book is likely to prove of great value to municipal authorities who are faced with the problem of determining the most satisfactory road material to employ both where traffic is heavy and where it is moderate. T. H. B.

OUR BOOK SHELF.

Die physikalischen Eigenschaften der Seen. By Dr. Otto Freiherr von und zu Aufsess. Pp. x+120. (Brunswick: Vieweg and Son, 1905.) Price 3 marks.

THERE are many books and pamphlets dealing with one or several of the properties of lakes; the aim, however, of the present work is to gather into a handbook the principal facts known, and to give a general view of the results arrived at, so as to incite the lover of nature to interesting observations as well as to provide a guide for the more specialised limnologist.

In a short introduction the author deals with Prof. Forel's work as having caused the important development of limnology which recent years have witnessed, and gives this authority's definition of a lake as being "a mass of still water, closed up on all sides, situated in a depression of the ground, without direct communication with the sea." The lake surface being a part of the earth surface represents a section of a sphere, the curvature of the same being, with large

lakes, important enough to prevent the observer from seeing low objects situated on the opposite shore.

Some preliminary remarks deal with general considerations on pressure, density, and compressibility of the water. The mechanical part includes the study of the different movements to be observed in lakes, viz. progressive waves, such as are known to everybody, stationary waves or "seiches," and currents. "Seiches" were first rationally studied by Prof. Forel in the Lake of Geneva, and have been found to exist in many other lakes; they are, for instance, now being investigated in the lochs of Scotland by the Lake Survey. Being waves as long as the lake, they cause periodical rising and falling of the water-level, though these tides are very often inconspicuous, and only to be recorded by limnimeters or registering apparatus; they vary from some millimetres up to 1.87m. (highest "seiche" in the Lake of Geneva), and much more in the great lakes of America. This special kind of wave, which affects the whole body of the lake, is probably due to several factors acting together or separately, such as sudden variation of atmospheric pressure, changes in the strength or direction of the wind, &c. Older explanations, as lunar attraction or earthquakes, have been shown to be untenable as general causes of "seiches."

The acoustic properties of lakes are dealt with in a short chapter. The most attractive feature of any lake is its colour, its greater or less transparency, its reflection of the surroundings, and other optical phenomena, such as refraction in or above the water. The explanation, however, of all these facts, which anybody may observe and enjoy, is often difficult and intricate even to men of science. The author of the present work has the merit of dealing with this optical chapter in a very intelligible and attractive way, giving briefly the most accredited theories of the phenomena treated of.

The last chapter deals with the thermic properties of lakes, such as distribution of temperature, seasonal changes, formation of ice, and storage of the summer's heat by the water.

A bibliographical list of the most recent and important works on physical limnology concludes the book, and makes of it a very useful guide and an excellent *résumé* of the actual state of our knowledge of this subject.

A Catalogue of North American Diptera or Two-winged Flies. By J. M. Aldrich. (Smithsonian Miscellaneous Collections, part of vol. xlvi.) Pp. 680. (City of Washington, 1905.)

THE second edition of Osten-Sacken's "Catalogue of North American Diptera" was published in 1878, and an enormous amount of work in the order has naturally been accomplished since. Prof. Aldrich's catalogue takes in the whole of North America, from Panama on the south to Greenland and the Aleutian Islands on the north; and also the whole of the West Indies, even down to Trinidad, adjoining Venezuela. "There is no place to draw a line between the islands. The Bermudas and the Hawaiian Islands are not included."

According to our own knowledge of other orders, we cannot quite agree with Prof. Aldrich. The fauna of Trinidad appears to us to have no relation to that of the islands further north, and to be purely South American, while the Bermudas clearly belong to North America. On the other hand, that of the Hawaiian Islands (apart from introduced species) is one of the most insular in the world; and, in this respect, may be compared with that of New Zealand, though far less conspicuous or extensive.

Prof. Aldrich has not numbered or mentioned the number of species admitted in his catalogue (which is brought down to January 1, 1904); but we may say that the introduction occupies 4 pages, the system of classification 1, the bibliography (with additions) 77, the index of (59) families 1, and the index of genera 12. The catalogue itself occupies 582 broad pages, and the distribution and synonymy appear to be very fully given. To criticise such a work in detail would only be possible for a specialist in Diptera, and in any case would occupy much more space than we could give to it; and we have, therefore, confined ourselves to observations on its scope and contents.

Elementary Experimental Science. An Introduction to the Study of Scientific Method. By W. Mayhowe Heller, B.Sc., and Edwin G. Ingold. Pp. 220. (London: Blackie and Son, Ltd., 1905.) Price 2*s.* 6*d.* net.

THE course of work in elementary science presented by the authors of this little book is modelled upon the plan which, it is satisfactory to know, is adopted in all good modern secondary schools. The consequence is that there is little which is new in the volume, though the methods of presenting familiar experiments and of setting forth practical instructions for laboratory exercises supply abundant evidence of the experience and teaching ability of the authors.

The book is quite suitable for the use of young pupils except for the paragraphs containing hints to teachers which are scattered up and down the chapters. It is unwise to lead children to suppose their teachers to be in need of instruction, and it may be asked, "May it not be supposed that most teachers have acquainted themselves nowadays with the aims and methods of elementary science instruction?" In any case, the teacher should not be addressed directly in the book intended for the use of his pupils.

The book is interesting since it shows that in the opinion of some at least of the most enthusiastic advocates of "heuristic" methods of instruction there is a good purpose served by a well-arranged text-book in introducing children to the study of scientific method. Teachers looking for a book containing a sensible, practical course of work in science should examine this one with care.

Astronomischer Jahresbericht. By Walter F. Wislicenus. Vol. vi., containing the literature of the year 1904. Pp. xxxvii+612. (Berlin: Georg Reimer, 1905.) Price 19 marks.

THIS is the sixth year of the issue of this very valuable publication, and it possesses all the vitality of the former volumes. It was thought by the reviewer of the previous year-books that the publication of the branch E, astronomy, an annual issue of the International Catalogue of Scientific Literature, would take the place of the present compilation, since they both for the most part cover the same ground. This, however, seems not to be the case, and perhaps the reason lies in the fact that the volume before us gives in many cases a brief *résumé* of the contents of the book or publication to which reference is made.

The present volume contains 2280 references, and as these with their brief summary of contents cover 595 pages, and an excellent "name" index which follows is responsible for another 17 pages, the matter contained therein is considerable.

The high standard maintained throughout reflects the greatest credit on the compiler and his seven co-workers, and renders the volume a necessary and valuable addition to every astronomical library and observatory.

W. J. S. L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Problem of the Random Walk.

THIS problem, proposed by Prof. Karl Pearson in the current number of NATURE, is the same as that of the composition of n iso-periodic vibrations of unit amplitude and of phases distributed at random, considered in *Phil. Mag.*, x., p. 73, 1880; xlvii., p. 246, 1899; ("Scientific Papers," i., p. 491, iv., p. 370). If n be very great, the probability sought is

$$\frac{2}{n}e^{-r^2/n}rdr.$$

Probably methods similar to those employed in the papers referred to would avail for the development of an approximate expression applicable when n is only moderately great. RAYLEIGH.

Terling Place, July 29.

The Causation of Variations.

IT is sometimes said that natural selection has ceased as regards civilised man; but very clearly this is an error. All civilised and most savage races are very stringently selected by various forms of zymotic disease. Thus in England practically everyone is brought into contact with the organisms which give rise to tuberculosis, measles, and whooping-cough; those individuals who are the most resistant to the organisms repel infection (*i.e.* do not fall ill), the less resistant suffer illness but survive, the least resistant perish. Abroad, malaria, dysentery, and many other complaints play a similar *rôle*. Probably no one is absolutely immune to any disease; but since illness only follows invasion of the tissues by a sufficient number of the microbes (the sufficiency of the number varying with the individual attacked), and since the microbes are more abundant in some localities than in others, the stringency of selection as regards any disease is greater in some places than elsewhere. For example, selection by tuberculosis is more stringent in the slums of cities than in the country. It should be noted, also, that resisting power against any one disease does not imply resisting power against any other; thus an individual innately strong against measles is not necessarily strong against tuberculosis. The result of all this elimination by diseases demonstrates the action of natural selection very beautifully. Every race is resistant to every disease strictly in proportion to its past experience of it. Thus Englishmen who have suffered much from tuberculosis are more resistant to it than West African Negroes who have suffered less, and much more resistant than Polynesians who have had no previous experience of it; that is, as a rule, Englishmen, under given conditions, contract the disease less readily, or if infected recover more frequently, or if they perish do so after a more prolonged resistance than Negroes and Polynesians. Negroes, on the other hand, as South American plantation experience proves, are more resistant to malaria than Asiatic coolies, who in turn are more resistant than Englishmen and Polynesians.

Against some diseases (*e.g.* tuberculosis) no immunity can be acquired, that is, experience of the disease confers no increase of resisting power, the disease pursuing a course of indefinite length. Against other diseases (*e.g.* measles) immunity may be acquired, that is, experience of the disease, if not fatal, confers after a definite time a more or less permanent immunity on the sufferer. In the former case the survivors are mainly those who have an inborn power of *resisting* infection; in the latter they are those who have an inborn power of *recovering* from infection. Evolution has proceeded on these lines. Thus Englishmen are less readily infected with tuberculosis than Polynesians, but nearly all Englishmen, like Polynesians, readily take measles, though a much greater proportion of them survive and acquire immunity. Lastly, in relation to such very "mild" diseases as chicken-pox, which render the individual very ill while they last, but cause hardly any elimination, no race appears to have undergone any change; for instance, no race, apparently, is more resistant to chicken-pox than any other race.

The pathogenetic organisms of all prevalent human diseases are more or less entirely parasitic on man. Most of them, therefore, flourish best in crowded populations, where they can pass readily from one susceptible individual to another. Thus tuberculosis is most prevalent in the slums of great cities. An important exception is malaria, the parasites of which require special conditions, and which, therefore, is more prevalent in the open country than in towns. The inhabitants of the eastern hemisphere have been afflicted by a multitude of zymotic diseases for thousands of years. Of old, with the increase of population, the conditions slowly became worse, the stringency of selection became greater, and the human races underwent continual evolution. But before the voyage of Columbus zymotic disease, with the exception of malaria, appears to have been almost, if not quite, unknown in the New World. We have fairly definite accounts of the first introduction of most Old World diseases to this and that aboriginal race, and of the frightful destruction of life that followed, the principal agent of elimination being tuberculosis. With their diseases the European immigrants introduced modern civilised conditions of life, especially churches, schools, and other enclosed spaces in which the natives, crowded together, conveyed infection to one another, and clothes, which acted as a deterrent to cleanliness, and which, besides, harboured the microbes of disease better than the naked skin. As a consequence, except when protected by malaria in extensive forests or when dwelling remote in unsettled regions, the natives rapidly perished. It is a significant fact that, whereas in Asia and Africa every town inhabited by Europeans has its native quarter, no European town in the temperate parts of the western hemisphere (*i.e.* where tuberculosis is most rife) has its native quarter. Published health statistics demonstrate quite definitely that the abnormally high mortality of the natives is caused by introduced diseases. Since civilisation implies a dense and settled population, it follows that no race can now achieve civilisation that has not undergone evolution against tuberculosis and kindred diseases. The case of the Negroes is interesting. In Africa they had undergone some evolution against tuberculosis. In America, when they were first taken to it, the disease prevailed to a comparatively slight extent, especially amongst the agricultural population; but the conditions slowly became worse, and the descendants of the early slaves underwent concurrent evolution. To-day they are able to persist in the northern cities, though their death-rate there is still abnormally high. But though a constant stream of Negro slaves and soldiers (*e.g.* in Ceylon) was poured for centuries into parts of Europe and Africa, they have left no trace on the population. All perished in a few generations, the elimination being so stringent as to cause extinction, not evolution. It is tolerably certain that a fresh immigration of African Negroes to America would end as disastrously.

These facts appear to establish conclusively two truths, first that evolution is due solely to natural selection, and second that variations, except, perhaps, in rare instances, are not due to the direct action of the environment on the germ-plasm, but are "spontaneous." The Lamarckian doctrine is quite out of court. If ever acquirements are transmitted, it should be in the case of the profound and lasting changes affecting the whole body which result from disease; but in no instance is the effect produced by any disease on the race similar to that produced by it on the individual. Thus tuberculosis injures the individual but confers resisting power on the race; measles confers immunity on the individual, but none on the race. Were the Lamarckian doctrine true, man could not persist on the earth. Presumably this is true of all other species, since probably all organisms are subjected to causes of slow deterioration similar to disease. If ever external agencies acting directly on the germ-plasm alter its composition and so cause variations (of any sort) in offspring,

it should be when germ-cells are literally soaked for prolonged periods in some virulent toxin such as that of malaria. Presumably the effect should be a harmful one, and it should act in much the same way on the germ-cells of one individual as on those of another; the race should, therefore, by the accumulation of injury, steadily deteriorate until it becomes extinct; but in no case is this observable. A disease may exterminate a susceptible race, but there is no evidence that it is ever a cause of racial degeneration. The same is true of races exposed to the complex of harmful agencies which surround urban life—filth, over-crowding, lack of light and air, of suitable food and exercise, and so forth. None of the races which have been longest and most exposed to them have become degenerate—for example, the Chinese, the Hindoos, the Egyptians, and the inhabitants of Europe. These races have merely become permanently resistant, preeminently capable of an urban existence. Red Indians and Polynesians perish *en masse* under such conditions. There is not an iota of evidence which demonstrates that the children of peasants if removed at birth to the city would on the average be better developed than the descendants of a line of slum dwellers. The legend that urban families tend to become extinct within four generations is founded on the fact that migration and inter-marriage betwixt town and country is so great that no families purely urban for four generations exist.

Bearing in mind the fact that races grow resistant to all diseases to which they are exposed, the only conceivable non-miraculous cause of evolution (*i.e.* adaptation) is natural selection. But natural selection cannot act when any agency (*e.g.* malaria) causes a drift in a particular direction, *i.e.* when all variations are unfavourable, and offspring tend always to fall below the parental mean. Students of evolution have generally thought of elimination in terms of sudden death as by the agency of carnivorous animals, when the individual who perishes dies in the fulness of his strength, and the individual who survives is strengthened rather than weakened by his efforts to evade destruction. It is clear, however, when considering causes of slow deterioration, which affect practically the whole population during youth, that the doctrine of natural selection is incompatible with the doctrine that variations are caused by the direct action of the environment. It is clear also that natural selection itself must always tend to establish a high degree of insusceptibility to direct action. A greater or lesser degree of susceptibility of the germ-plasm is itself a variation. The more susceptible type of germ-plasm tends continually to be eliminated, and a high degree of insusceptibility established. This is not the same thing as saying that the germ-cells are inviolable and cannot be injured It is only implied that their "hereditary tendencies" are implanted in them almost as firmly as life. The behaviour of somatic cells confirms this view. A gland, for example, may be diseased for twenty years, yet on recovery we do not find a new type of cells; on the contrary, the descendant cells are quite of the old type.

No doubt many instances of the alleged direct action of the environment on the germ-plasm have been recorded. Thus medical men have published statistics to prove that the children of alcoholics and consumptives tend to be insane; but as a rule this evidence is inconclusive in that it fails to demonstrate that the proportion of insane is higher among them than among the offspring of normal parents. Numerous other factors of error, also, are not taken into account. In some cases published by biologists acquirements do not seem to have been clearly differentiated from variations. Thus in the well known case of Weismann's butterflies ("Germ-Plasm," p. 399) we are not told that the darkening of colour produced by a higher temperature was accentuated during subsequent generations by similar treatment, nor that the darkened individuals reproduced their like in the absence of the high temperature. *A priori* there is no apparent reason why acquirements should not be made in the germ-cell stage of the individual as well as during subsequent stages of development. In other cases, as when plants have been removed to a new environment, the effects of a different survival of the fit have not apparently been taken into account. It must be remembered that natural selection not only adapts organisms to changing environments, but keeps them stable in stable environments, and so eliminates the variations which appear in the new surroundings.

It is not necessary, of course, to believe that variations are never caused by the direct action of the environment. Presumably the insusceptibility of the germ-plasm is due to evolution, and evolution is never perfect. It is only necessary to believe that in circumstances normal to the species the insusceptibility is so high that the amount of variations produced by the direct action of the environment is so minute as to be negligible, *i.e.* not a cause of racial change. It is possible that when species are removed to very new environments (*e.g.* European dogs to India or horses to the Falkland Islands) the germ-plasm is sometimes changed by conditions to which natural selection has not rendered it highly insusceptible; but the deterioration which is said to result in such cases is clear evidence of the necessity of this insusceptibility. If it be not established the species must perish.

G. Archdall Reid.

The Empire and University Life.

In your issue of July 6 your powerful advocacy of a higher and broader education in our great universities casts me back in memory to more than fifty years ago, when I first was transported with delight at F. von Schlegel's great generalisation of the unity of the Indo-European family of languages. I was then astounded that Oxford and Cambridge, through so many centuries, had not seen this great truth.

The theological and catastrophetic method had darkened the mental vision of both Oxford and Cambridge; even the mighty Whewell, in 1846, wrote from Cambridge:—"Not only, then, is the doctrine of the transmutation of species in itself disproved by the best physiological reasonings, but the additional assumptions which are requisite to enable its advocates to apply it to the explanation of the Geological and other phenomena of the earth, are altogether gratuitous and fantastical."[1]

From Oxford, her powerful son, the G.O.M., could not rise to feel that the first chapter of Genesis was a sublime poem; he could not rise to feel the truth of the most elementary facts of geology; so enchained was his mind that he could not feel the poetry and spirituality of the "Sacred Books of the East"; the Hindu philosophers and poets give their ideal demi-gods a vast age, even to 900,000 years; but they know that it is poetry and ideal. But Oxford's greatest son could not rise to such elementary generalisation; he saw the great doctrine of "continuity" no wider than the concrete mythology of the Hebrews—he believed in the literal and personal Methuselah of 969 years!

These modern examples of bad method are but glaring "instances" of the general bad method which permeates society, permeates the professions, above all, the professions of theology and medicine.

The Method (see Coleridge) of Oxford and Cambridge in its influence on its sons always reminds me of the words of Sismondi[2]; writing of the "erudition" of the Greeks of the tenth century, Sismondi says:—"Few (of their) books seem better constructed to show the vanity of erudition, and to place in strong contrast a vast extent of knowledge, with a total incapacity of deriving any useful results from it." "Were it necessary to choose between the whole experience which has been acquired and collected from the beginning of time, the whole rich store of human wisdom, and the mere unschooled activity of the human mind, the latter ought, without hesitation, to be preferred. This is the precious and living germ which we ought to watch over, to foster, to guard from every blight. This alone, if it remain uninjured, will repair all losses; while, on the contrary, mere literary wealth will not preserve one faculty, nor sustain one virtue."

We do not want revolution, but an active evolution, both at Oxford and Cambridge, based, as Coleridge said, on the "historic sense."

May I add my personal experience, that I have been able to converse in a more genial, enlightened spirit and

1 "History of the Inductive Sciences," 3rd ed., 1857, vol. iii. p. 481.
2 "Fall of the Roman Empire," vol. ii., pp. 258, 261 (1834).

method with Hindu Brahmans and gentlemen, and with cultured Moslems, in India, than I find it possible to do with clerics, the professional classes, and society magnates in Britain.

It is to be hoped that "more light" will evolve at Oxford and Cambridge, and a higher and truer method permeate their sons.

GUNGA-GUNGA.

A Solar Outburst (?).

REFERRING to the note on solar activity in your issue of July 20, I shall be glad to know whether any correspondent observed a luminous outburst in the tail end of the great spot on the evening of July 16. I had been observing in the afternoon with an 8½-inch reflector, but remarked nothing of the sort. At 5.30, however (the sun having got beyond range of my reflector), I was observing him with a small refractor, power 12, and sun-cap, when I at once noted the luminous appearance in question. It was roundish and about the size of the small spot near following limb, and it was brighter than the bright bridge in the large group. I watched this bright spot until 7.30; next morning it had practically disappeared. Father Cortie courteously informs me that the Stonyhurst magnets were perfectly quiet on July 16, but that next morning, at 8.15, there was a "very small but sudden and sharp movement on both the declination and horizontal force curves." By that time the locality where the luminous appearance occurred would not be far from central meridian. I also noticed a rosy hue pass over the bright bridge of great spot, but this may have been a mistake. I am, however, certain of the luminosity.

Cardiff, July 24.

ARTHUR MEE.

A CENTURY'S PROGRESS IN WARSHIP DESIGN.

THE interesting paper read by the Director of Naval Construction at the summer meeting of the Institution of Naval Architects brings vividly home to us the progress made in the design of warships since Nelson fought, off Cape Trafalgar, our last great sea fight. In our account of the proceedings at the meeting, printed last week, we referred to Sir Philip Watts's paper, but it is worthy of more attention than brief mention in a report of a society's meeting.

We reproduce from among the illustrations accompanying the paper the sheer draught of Nelson's last ship, the *Victory* (Fig. 1). The original drawing of this most famous of all vessels of the Royal Navy was shown at the meeting when the paper was read. We also reproduce the sheer draught of the 36-gun frigate *Syrius* (Fig. 2), as affording an interesting comparison with a modern cruiser. As is well known, the *Victory* was forty years old at the date of Trafalgar, so that as she now floats in Portsmouth Harbour she numbers 140 years. She was, however, reconstructed in 1798, seven years before Trafalgar, and again in 1820. The effect of her first reconstruction is shown by the dotted lines of the engraving. The long time that the *Victory* remained on the active list is indicative of the slower progress of invention that characterised former times. If we go somewhat further back we have a still more striking example in the *Royal William*, a model of which 100-gun line-of-battle ship was shown at the Naval Exhibition of 1891. She was built at Chatham Yard in 1670, was rebuilt at Chatham in 1692 on the same lines as those on which she was originally designed by Phineas Pett, and was again rebuilt at Portsmouth in 1719. As she was not broken up until August, 1813, she was in existence when the battle of Trafalgar was fought; but as Sir Philip Watts does not include her in his table of ships of the Royal Navy, October, 1805, we may conclude that before that date she had ceased to be considered efficient.

The long life of the warships of past times was not due to their more durable construction as compared to modern vessels, but to the lack of that inventive enterprise now made possible, primarily, by James Watt's labours. A steel vessel well built and properly kept up would be practically indestructible with fair treatment; but the same cannot be said of wooden ships. It is not because sound wood in itself is less strong than iron or steel, weight for weight, so much as that it cannot be procured in sufficiently long and conveniently sized pieces, a large number of joints and overlappings thus being necessary; but the chief drawback to wood is that it is not so suitable a material for making joints; as Sir Philip Watts says, "The fastenings cannot develop the strength of the main body of the material." A seam of rivetting in a properly designed steel vessel will join plates to frames or beams, or plates to plates in a way that no buffeting of the winds and waves will affect. That is not the case with the fastenings of wooden ships; as a matter of fact, most of the old men-of-war became "hogged" after some years of service. The frequent reconstruction of wooden vessels of which we read was the result of these conditions.

The causes which thus led to the decay of wooden ships, as individual structures, contributed to the permanence of their respective types, especially in regard to ships of the line. As Sir Philip Watts points out, it was "owing to the limitations imposed on shipbuilding, when wood was the only available material, that length could not be largely increased without reducing to a dangerous extent the longitudinal strength of ships, and the only practicable means of largely increasing the number of guns was to increase the number of decks for carrying them." There were, however, limitations to the extension of vertical dimensions as well as to the increase of horizontal dimensions. A few four-deck ships were built, but the advantages of the extra gun positions thus secured were more than counterbalanced by the defects of a high, unwieldy structure above water. Even three-deckers were at a disadvantage owing to their high sides; they were "worse sailors and less handy in manœuvring than two-deckers"; and, indeed, when one looks at the old *Victory* towering above water, riding to her moorings in Portsmouth Harbour, one wonders how these ships were ever sailed in any direction excepting broad off the wind. The high positions of the guns also necessitated a greater amount of ballast to give stability. All these circumstances joined in confining the naval architect to short ships; and once Phineas Pett had developed construction to the full extent allowed by the limitations of wood as a material, and wind as a source of motion, there was little more to be said. Charnock, speaking of the *Prince Royal*, designed by Pett at the beginning of the seventeenth century, has said, "This vessel may be considered the parent of the identical class of shipping which, excepting the removal of such defects or trivial absurdities as long use and experience has pointed out, continues in practice even to the present moment." That sentence bridges over a period of more than 200 years of the history of naval design.

When it was recognised that iron could be used for the construction of ships—that it was not, as some averred at the time, "contrary to the laws of Nature"—then the horizon of the naval architect widened as when fog lifts at sea. To design a ship of adequate strength became a science, for the stresses that hull structure of given scantling would stand could be calculated with precision; mathematics and a knowledge of physics took the place of bolts and

trenails. Before this era English models had fallen sadly behind those of our chief rivals. It was by hard fighting, not by superiority or even equality of design, that victories were gained for our arms. Creuze, in his "Treatise of Naval Architecture," published in 1846, speaks of the inferiority of British ship design, quoting Charnock to the same effect. "When an English fleet was in chase of a French fleet it was ships which were British built that fell into our possession; but almost on every occasion the French ships could evade ours. The losses sustained in the French Navy by foundering at sea, or by wrecks were principally those ships which had been taken from us. On the contrary, the favourite ships in our fleets were those which had been taken from the French, and the instances in which French ships in our service were ever recovered possession of by them were extremely rare; we as far exceeding them in all that related to the manœuvres and management of ships as they did us in designing them." As is well known, the *Foudroyant*, a two-deck ship captured from the French in 1758, served as a model for a new class, or, again to quote Creuze, "a very superior class of man-of-war which was adopted."

It was not, however, with the abandonment of wood that England ceased to follow the lead of France in ship construction. We remember that the first iron-clad ocean-going war vessel, *La Gloire*, was French; and Sir William White in 1887 said, "it must be frankly admitted that the lead taken by the French on both the steam and ironclad reconstructions was the primary cause of most subsequent activity in warship building."

We dwell on this point because it illustrates the evil of neglecting the application of scientific principles to practical affairs. Happily, since the period to which we have referred Great Britain has done much to remove the reproach under which she formerly rested. The labours of Scott-Russell, Rankine, William Froude, and many others raised ship design in this country to a position of which we may well be proud. Some of the later workers, like the late William John, have passed away, but, happily, the majority—and we may cite the author of the paper as among the most distinguished—are still with us. It is fair to add that it is to the establishment of the Institution of Naval Architects this improvement is mainly due; and, since its foundation in 1860, the application of scientific principles to ship design has made progress rapid beyond all precedent. Annual meetings bring together the leading members of the profession for the interchange of ideas, and in the *Transactions* of the institution may be found memoirs by the best authorities on all subjects connected with the science of naval architecture.

It is well to remember, however, that, whilst there is much room for congratulation, the need for effort towards progress still exists, and perhaps to a greater degree than ever. For long after the introduction of steam propulsion, Great Britain, as the leading shipbuilding nation, held a position not seriously challenged. We gave examples to the rest of the world; others took their practice from us. Of late, however, our supremacy has been attacked. There are shipyards and marine engine works, many of them splendidly equipped, in all the most important countries, and we may depend every effort will be made to employ them fully and develop them further. The naval Powers are determined to construct their navies within their own domains, and some foreign Governments are giving inducements to shipowners and shipbuilders of a substantial nature, and such as are not offered in this country. It is well to remember that Germany for some time past has not only possessed, but has constructed within her own domains, the mercantile vessels which hold the premier position in the world.

In shipbuilding, as in nearly all other manufacturing industries, we must neglect no chances. To design a complex structure such as a high-class modern steamship needs an amount of accurate knowledge intelligently applied—that is to say, an amount of science—which is only within the com-

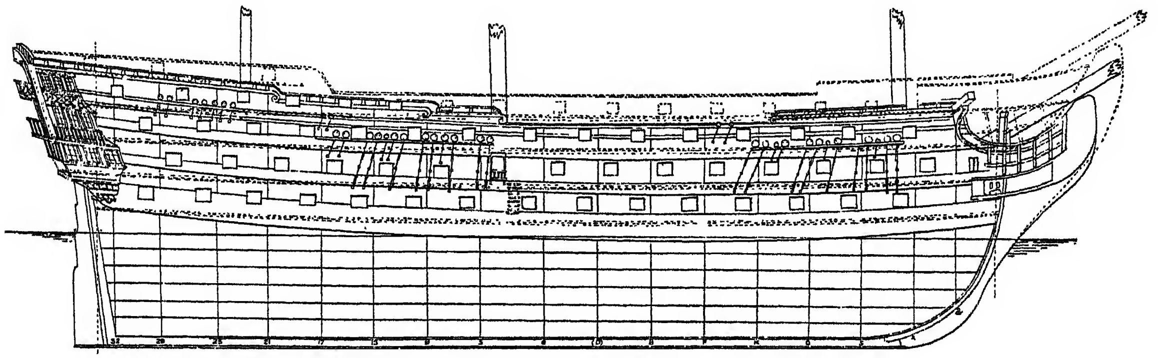

FIG. 1.—Navy Office, June 6, 1759. Sheer draught of 100-gun vessel *Victory*. Length on the gun decks, 186 ft.; Length of the keel for tonnage, 151 ft. 3[illegible] in.; breadth extreme, 51 ft. 10 in.; breadth moulded, 50 ft. 6 in.; depth in hold, 21 ft. 6 in.; burthen in tons, No. 2162[illegible]; the dotted outline shows the vessel as altered.

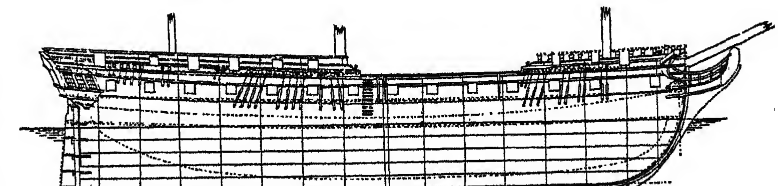

FIG. 2.—Navy Office, September 30, 1795. Sheer draught of 36-gun frigate *Syrius*. Length on the lower deck, 148 ft. 10 in.; length of the keel for tonnage, 124 ft. 0[illegible] in.; breadth extreme, 39 ft. 7 in.; breadth moulded, 38 ft. 11 in.; depth in hold, 13 ft. 3 in.; burthen in tons, No. 1033[illegible].

mand of those having every advantage for its acquirement. We here say "design," not copy, for the man or the nation that copies must necessarily lag behind those who originate. It is not a good sign—it is distinctly a bad sign—that, in spite of the efforts of some public-spirited and thoughtful members of the Institution of Naval Architects, shipowners and shipbuilders at large have not subscribed the really modest sum needed for establishing the proposed experimental tank at the National Physical Laboratory. It is by the aid of such a tank that the data needed for the scientific design of a vessel can be worked out in their completeness; and such accurate knowledge as we have about resistance of ships is due to researches made by the aid of models in tanks. It is many years since an Englishman, Froude, established the first tank at Torquay, and, by his incomparable experimental work and scientific deductions, put at our disposal the information needed to prosecute further inquiries in this direction; and now, after more than thirty years, although we claim to be the leading shipbuilding nation of the world—as we are in regard to bulk of tonnage constructed—Mr. Yarrow has to depend on a German tank when he seeks information as to the resistance of vessels in varying depths of water. If our shipowners would devote a small part of the energy they expend, and an infinitely small part of the money they waste on freight-wars to an attempt to improve the designs of their vessels, it might tend to the stability of the British shipbuilding industry and to more satisfactory balance-sheets; it certainly would to a more worthy record of the country's progress in ship design.

Sir Philip Watts, who, as Director of Naval Construction, has at his command the well equipped and admirably staffed Government tank at Haslar, does not feel the need of such an establishment, and naturally does not refer to it in his paper. He gives, however, a sketch of the plan followed in scarphing frames and planking together so as to reduce the working of the different pieces on each other. The science of the metallurgist has removed that necessity by giving us a material which enables the side of a ship to be made practically a continuous structure. The outer planking of ships of the line at the time of Trafalgar was 8 inches to 4½ inches thick above water, and planking on the inside of the frames was from 4 inches to 5 inches thick. The frames themselves composed almost a solid wall, so that a combined thickness of nearly 2 feet—the thickness of the iron armour on the *Inflexible*—was available for resisting shot. Great attention was paid to seasoning timber; but when it came to a case of metal construction our ancestors were often a little at fault. "The older ships of the Trafalgar period were iron fastened and sheathed with copper. Considerable trouble was, however, experienced by the corrosion of the iron fastenings, so much so that in some cases, after three or four years, the ship was rendered unfit for foreign service. The intervention of substances such as felt, tarred paper, &c., between the copper and the wood bottom failed to protect the iron entirely, and at one time the Board of Admiralty contemplated discontinuing the sheathing of ships lying in ordinary and fitting it to them immediately before going to sea." Thus do we see how the want of a little knowledge of natural laws caused inefficiency and loss of money; but there was excuse for our predecessors which we, who have their accumulated experience, cannot plead.

Sir Philip Watts gives some interesting figures as to the cost of the older ships, and these may be compared with that of modern vessels. In 1719 the cost of the *Royal William*, of 1918 tons, was 30,800*l*., or about 16*l*. per ton. Whether or not this refers to Pett's *Royal William*, reconstructed in 1719, is not certain, but probably it does. In that case a good deal of the original structure might have remained, thus lessening the cost. The *Royal George*, of 2046 tons, built in 1756, cost 54,700*l*., or 26·7*l*. per ton. "In 1800 ships of the line cost 21*l*. per ton, whilst in 1805 the cost had risen to 35·4*l*. per ton." These figures presumably refer to displacement tonnage, but whether guns are included we are not aware; we will conclude they are not, and see how former figures compare with those of the present day. The first class battleship *King Edward VII.*, of 16,350 tons displacement, is to cost 1,410,901*l*., excluding guns and ordnance stores; whilst the guns will come to 89,070*l*., bringing the total cost to within a few pounds of a million and a half. This would be somewhat over 86·2*l*. per ton, without guns, as compared to 35·4*l*. per ton at the date of Trafalgar. If, however, we could measure cost in terms of fighting efficiency we should doubtless find that we now get more for our money than our fathers did in 1805, for the *King Edward VII.* could have engaged the whole of the British Fleet at Trafalgar with the allied fleet thrown in. In armament the advance has been no less striking. The old cast-iron smooth bores, with their wooden truck carriages, were trained by handspikes, used as levers under the brackets, and by side tackles; and they were elevated by handspikes, being held in position by quoins. Sir Philip Watts says that "a 32- or 24-pounder, fought on the lower deck, had a range of only about 2000 to 2500 yards with 8° elevation, and of about 1500 yards with 4° elevation. The powder charge was generally one-third to one-quarter the weight of the shot. At close quarters a 24-pounder was said to be able to penetrate nearly 5 feet of solid oak and an 18-pounder half this amount." These were not the heaviest guns in the service at the beginning of the last century, there being 42-pounders also; but guns of this nature, designed to form the principal armament for the lower decks of the largest battleships, were found to be too heavy to be worked quickly by the rude appliances then in use. A still heavier piece was later introduced, namely, the 95cwt. 68-pounder.

We have not information as to the thickness of solid oak which the round shot fired from these heavier natures would penetrate, but we may compare the 5 feet that would be pierced by the 24-pounder with the power of the guns of the present day. The modern 12-inch wire-gun of the Royal Navy, weighing 50 tons (about twenty times as much as the 32-pounder), is estimated to penetrate 42 inches of wrought-iron at muzzle velocity of 2580 foot-seconds and a muzzle energy of 30,280 foot-tons; at 1000 yards the penetration would be 38 inches of wrought-iron, at 2000 yards 34·6 inches, and at 3000 yards 32 inches. The penetration of Krupp steel armour at 3000 yards would be but 14 inches. These results are with uncapped projectiles. The longer 12-inch guns of Armstrongs or of Vickers will penetrate more than 51 inches of wrought-iron and will fire two rounds per minute.

It will be seen from the above facts how enormously the powers of both attack and defence have increased during the century. They would seem to have progressed in about equal ratio, for Sir Philip Watts says that "the capability of the wooden ship to take punishment from the guns of her time was, except in one important respect, much the same as that of a modern ironclad." The important respect, of course, refers to the shooting away of spars and rigging.

A table given by Sir Philip Watts comparing the weights apportioned to the different elements of design in a battleship of 1805 and of a modern battleship respectively is interesting. The old ship is one of 74 guns, and 20 per cent. of the total displacement was awarded to general equipment as against 4 per cent. for the 1905 battleship. Armament in 1805 was 10 per cent. of the displacement; in the present day it is 19 per cent. The propelling arrangements are somewhat in the nature of a surprise, masts, sails, and rigging absorbing 8.5 per cent., and steam machinery only 10.5 per cent. of the displacement. There is, however, to be added to the latter figure 5.5 per cent. for coal, but this is more than balanced by the 6.5 per cent. of the weight apportioned to ballast for giving the stability needed under sail. Armour is naturally the great point of difference, for it takes up 26 per cent. of the displacement of a modern battleship. As against this but 35 per cent. of the total displacement is needed for the construction of steel hulls, whilst the wooden hull absorbed 55 per cent. of the total tonnage. It must be remembered, however, that the construction of the "wooden walls" was far more massive than was needed for ordinary purposes, and a good part of the 55 per cent. might be set down as wooden armour. The remarkable thing is that iron plates were not applied earlier, before the French constructors set us the example; or, rather, it would be remarkable were the very conservative nature of the old admirals not remembered.

THE LIGHT-PERCEIVING ORGANS OF PLANTS.[1]

THE subject of this most suggestive book has already been dealt with by the author in a preliminary way.[2] In its present form it has gained greatly in force and interest, and whether or no we are finally converted to Prof. Haberlandt's views there can be no doubt that they are worthy of serious attention.

It is well known that the majority of leaves have the power of placing themselves at right angles to the direction of incident light, but the question of how the light stimulates the leaf to perform the curvatures and torsions which bring it into the "light position" is a problem which hitherto has hardly been attacked.

The first question to be solved is what part of the leaf is sensitive to light. By covering the blade of the leaf with black paper, &c., Haberlandt shows that the principal and most delicate sensitiveness resides in the blade, although a coarser and secondary sensitiveness to the incident light is found in the stalk. It results from this part of the inquiry that the lamina of the leaf must contain the organs for light-perception, if such organs exist. Anything corresponding to a visual organ may be expected to be on the surface, although in such a translucent organ as a leaf this does not necessarily follow. It may, however, be said that Haberlandt is amply justified in looking for what he calls the ocelli of plants in the epidermis covering the upper surface of the leaf. We may therefore narrow the problem thus. Imagine a horizontal leaf illuminated by light striking it obliquely from above at 45°; such a leaf is not in the "light position," and will execute a curvature through 45°, in fact until it receives light at right angles to its surface. Then curvature ceases and the leaf remains in a state of equilibrium—satisfied, as it were, with the "light position." The question is how the leaf differentiates between oblique and perpendicular illumination. Direct observation suggests an answer. If the epidermis of such a leaf as that of *Begonia discolor* be removed by a surface section, and mounted upside down and illuminated from below, then with a low power of the microscope it can plainly be seen that there is a bright spot of light on the basal (inner) walls of the epidermic cells. It can further be seen that the relation of the spot of light to the surrounding zone (which is more or less dark) changes when the specimen is obliquely illuminated. Thus in the case of the obliquely illuminated leaf we should have to imagine that the leaf is stimulated to curvature by the fact that the spots of light are not central in the cells, and that curvature ceases when the brightest illumination is once more central. Thus the plasmic membrane of the basal wall of each epidermic cell is supposed to have a quasi-retinal function by which the leaf is believed to orientate itself in regard to light. There is here, as Haberlandt points out, a certain resemblance to the mechanism by which plants are by many botanists believed to react to gravitation, namely, by the pressure of solid bodies on different parts of the cell walls, just as the statoliths (otoliths) of certain animals, by pressure on different parts of the membrane of the statocyst, enable them to orientate themselves in space.

Haberlandt shows that the epidermic cell is well fitted to concentrate light. It is very commonly lens-like in form, its outer wall being convex, its inner wall either plane or curved. Haberlandt shows by geometrical construction that, taking the refractive index of the cell sap as equal to that of water, the focus is usually at a point either within the cell or below it in the other tissues. In either case a central illuminated region and a surrounding dark zone is produced on the basal cell wall. A further development of this type is the papillose epidermic cells which give the velvety appearance to certain tropical leaves. This does not differ essentially from the first described type, but it has, according to the author, certain advantages which will be referred to later on. It must not be supposed that all leaves have lens-shaped epidermic cells; some leaves, known as aphotometric, are indifferent to the direction of incident light, and even in photometric leaves Haberlandt shows that discrimination is possible without the epidermis playing the part of a lens. Where the outer wall of the epidermis is flat, it often occurs that the inner wall bulges into the subjacent tissues or projects into them in the form of a truncated pyramid. In this case, when the light strikes the leaf at right angles, the central part of the basal wall, being more or less parallel to the surface, is more strongly illuminated than its peripheral parts, which are oblique. Thus without any lens-effect we get stronger illumination in the central region of the basal walls of the epidermis; and this may conceivably serve as a means of orientation.

The most conclusive proof of the author's theory is given by the results of placing the experimental plants under water. If he is right in claiming a lens-function for the epidermic cells, it is clear that immersion in a fluid which has approximately the same refractive index as the cell sap must interfere with the plant's power of light-perception; and this is, in fact, the outcome of his experiments.

His first experiments (p. 89) were made with the hop (Humulus). Here, as in other cases, the stimulus of light is perceived by the leaf, and less perfectly by

[1] "Die Lichtsinnesorgane der Laubblätter." By Dr. G. Haberlandt o. ö. Professor der Botanik a. d. Universität Graz. Pp. viii+143 (Leipzig: Engelmann, 1905.) Price 6s. net.

[2] *Berichte d. deutsch. bot. Gesellschaft*, Bd. xxii., 1904 (February), and in an address given in 1904 before the Gesellschaft deutscher Naturforscher und Aezte, and published by Barth, of Leipzig.

the leaf-stalk. Four leaves were immersed, two (D) having their leaf-stalks darkened with tin-foil, while the stalks of the other two (L) were exposed to oblique light. After three or four days the D leaves showed no signs of taking up the light-position, while the two L leaves showed well marked curvature towards that position. The experiment is of importance, since it shows that immersion in water does not prevent heliotropic curvature by interfering with respiration or by depressing the energy of the plant in any other way. The only explanation seems to be that of the author, viz. that in the leaves (D) with darkened stalks the lens-like epidermic cells of the leaf-blade are the only organs of light-perception, and they being thrown out of action by the presence of water, perception (and therefore curvature) is absent.

Experiments of the same type were made with a like result on *Ostrya vulgaris* and *Begonia discolor*. It is to be regretted that the light-perceiving organs of such leaf stalks as were sensitive to light under water were not investigated.

A striking result was obtained with Tropæolum (p. 92). The leaves of this plant are unwettable, and when immersed remain coated with a silvery mantle of air. The waxy layer, which gives this quality, may be removed by painting the surface with dilute alcohol without injury to the leaves. The result of immersion is that the normal leaves protected by a layer of air react normally to oblique illumination, whereas the wettable leaves have lost the power of so reacting. This interesting result suggests to the author a new function for the waxy "bloom" of leaves, *i.e.* that it saves them from being blinded by a shower of rain. This theory he extends to velvety leaves, the strongly papillated epidermic cells of which stand up like islands when the surface of the leaf is wetted (p. 65). This is a striking fact in relation to the distribution of velvet-leaved plants, which are especially common in damp tropical regions.

Another section of Haberlandt's evidence depends on the existence of highly specialised lenses. One of the most curious is that of *Fittonia Verschaffeltii* (Acanthaceæ), shown in Fig. 1. Here we have a

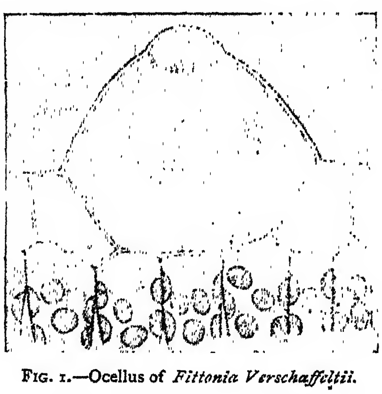

FIG. 1.—Ocellus of *Fittonia Verschaffeltii*.

dwarfed, two-celled trichome, of which the apical cell has the form of a biconvex lens. In this case there is a division of labour, the light focused by the lens-cell being perceived by the large basal cell. Direct experiment shows that, as might be expected, painting the leaf with water in no way interferes with the effect, since the lens is raised above the layer of wet. Similar ocelli occur in *Impatiens mariannae*, and here, as in Fittonia, it is interesting to note that the ordinary epidermic cells, among which the ocelli occur, are markedly bad lenses.

Quite a different type of lens occurs in *Campanula persicifolia*; here (Fig. 2) the formation of a spot of light does not depend on the form of the epidermic cell as a whole, but on the existence of a lens-shaped silicified region in the outer wall of the cell. These structures only occur in perfection in a shade-loving form of the species, where they were noted by Heinricher, who was unable to suggest a function for them. Direct observation proves that they are highly effective lenses. Similar organs are found in *Petraea volubilis*. We must pass over a number of other interesting specialised organs, but it is of importance to note that whenever ocelli occur they

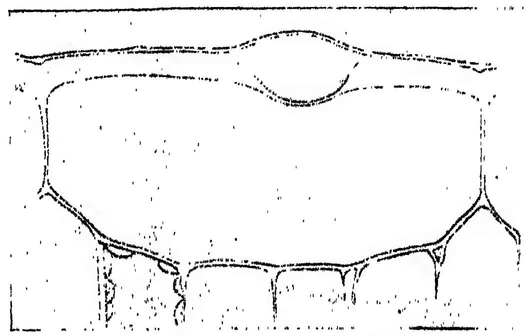

FIG. 2.—Ocellus of *Campanula persicifolia*.

are to be found on the upper, and not on the lower, surfaces of leaves. It is also particularly interesting to find that ocelli tend to occur especially near the edges of leaves, *i.e.* just in those regions where the amount of movement, corresponding to curvature through a given angle, is greatest.

The author has once more earned the gratitude of his fellows by his suggestive discoveries and speculations He must be allowed to have made out a strong case for his theory, but he would be among the first to grant that more work is needed before it can be considered as completely established.

F. D.

RECENT PUBLICATIONS IN AGRICULTURAL SCIENCE.

EVERY civilised State has recognised a special duty towards its farmers in the way of endeavouring to secure them against the purchase of adulterated manures, fraudulent feeding stuffs, and dead or impure seed, but different countries have taken very various means towards securing the desired end. The United Kingdom, probably because its representative farmers are men of substance, rather holds by the old *caveat emptor* maxim, and is content with providing the farmer with a machinery for getting an analysis below cost price, but a machinery sufficiently cumbrous to ensure that no one sets it in motion. Other nations, less intent, perhaps, upon a plausible case in Parliament, and more concerned in getting the thing itself done, have devised various systems of controlling the trade in such materials, so as to ensure that the smallest farmers shall be supplied with seed or manures reaching a certain standard of purity. The laws and methods adopted for securing such a control in the various States Prof. Giglioli passes in review,[1] giving an account of the testing stations, the regulations, the fees, and even notes on the working details employed in the labor-

[1] "Concimi, Mangimi, Sementi, &c., Commercio, frodi, e repressione delle frodi, Specialmente in Italia." By Italo Giglioli. Pp. xvi+759. (Rome: Annali d'Agricoltura, 1905.)

atories. To anyone interested either in the technique or in attempting to secure a more thoroughgoing system in this country, Prof. Giglioli's book will provide a storehouse of information.

We have before had occasion to comment upon the gigantic undertaking of the United States Department of Agriculture, which has embarked on the preparation of a map of the soils of the whole country on a scale of one inch to the mile, accompanied by analyses of each soil type with descriptions of its agricultural features and suitability to particular crops and methods of management. Criticism has not been wanting of the manner in which the work is being executed, but when something like 26,000 square miles are being surveyed and mapped in the course of a year at a cost of about 12*s.* per square mile little more than a first approximation can be expected. Objection has been taken to the system of adopting a local name, *e.g.* Norfolk sand, attaching it to a given soil type, and using it all over the continent for soils of that category, whatever their situation or origin. But the argument is after all a formal one, and the value or otherwise of the survey can only be judged by the farmer on the spot, who finds that it does or does not represent his own soil conditions and assist him to utilise them to the best advantage.

To the foreign reader these volumes[1] are chiefly valuable as giving details of the nature of the soil, the climate, and other factors of the notable farming areas in the United States. Here one can compare the conditions under which the very different wheats of the north-west or of the Pacific slope are grown, or make out the climatic and soil requirements of such crops as cotton in Louisiana or tobacco in Connecticut. We miss in the present volume the photographs of the country which, to the outsider at least, were one of the most interesting features in the former issues.

For many years Mr. T. Jamieson has been carrying on a series of agricultural experiments, or rather demonstrations, on a comparatively small scale, but in a very careful and neat fashion. Reports on the work done have been issued from time to time, and now the results, which extend over something like twenty-eight years, have been gathered together in the little volume before us.[2] The experiments illustrate the well known principles of plant nutrition, and the account of them affords a brightly written *résumé* of the elementary facts connected with manures and their application to various crops. When here and there we read that this or that fundamental fact has been discovered or proved by the Aberdeenshire Research Association, much as though Mr. Jamieson should tell us that he has discovered water is composed of eight parts of oxygen and one of hydrogen, we can only admire the innocence in which Mr. Jamieson has managed to preserve his mind. Not for him the knowledge of good or evil that comes of reading other men's work, either past or contemporary. We miss, indeed, in this volume some of Mr. Jamieson's engaging speculations, as when, in his 1903 report, he told us that potash "appears to be the element chosen in nature to neutralise acidity, and facilitate transmission within the plant, for which purpose it is specially fitted by its alkalinity, solubility and soft or slippery character. Soda, which closely resembles it, but is of a harder drier nature (as seen in the soft Potash Soap as compared with the hard Soda Soap) is unable to take the place of Potash in plants, as has been found by former experiments." But as a result the book forms a sufficiently sound and quite clearly written introduction to agricultural chemistry, which, like a visit to Mr. Jamieson's orderly demonstration plots at Glasterberry, may well be useful to set farmers thinking about the way their crops grow.

[1] "Field Operations of the Bureau of Soils, 1903." Fifth Report. Pp. 1310, and a case containing 78 maps. (Washington: U.S. Department of Agriculture, Bureau of Soils, 1904.)

[2] "Science and Practice of Agriculture—Farmer's Handbook." By T. Jamieson, Director of the Aberdeenshire Agricultural Research Association. Pp. 173. (Aberdeen: The Author, 10 Belmont Street, 1905.) Price 2*s.* 6*d.*

NOTES.

THE address on "Imperial Defence" delivered by Lord Roberts at a special meeting of the London Chamber of Commerce on Tuesday was a clear statement of the unsatisfactory condition of the armed forces of this country, in comparison with those of other great military Powers. Lord Roberts believes that we could not hope to be successful against an enemy of anything like equal strength, trained and organised as are the armies of leading nations. It appears, therefore, that we are as unprepared for war as Sir Norman Lockyer showed we are for the industrial competition of the future, in his presidential address to the British Association; and as to the way to remedy our deficiencies Lord Roberts's address—*mutatis mutandis*—supports the views expressed on that occasion. Higher education and scientific study must be applied to the arts of war as well as to those of peace if our country is to occupy a position in the first rank of progressive nations. Less attention must be paid to such trivial matters as the shapes of headdresses or the cuts of jackets, and more must be given to education and scientific training from early youth. In the war in the Far East, the Japanese have been successful because of their superior intelligence and scientific spirit. Let our statesmen learn from this that intellectual efficiency is now a truer safeguard of a nation than physical strength.

THE Government Eclipse Expedition organised by the Solar Physics Observatory will leave for Gibraltar on Friday. The expedition, in charge of Sir Norman Lockyer, K.C.B., will tranship there to H.M.S. *Venus*, which will proceed to Palma, where, by permission of the Spanish Government, the instruments will be erected. Mr. Howard Payn, one of the volunteer observers, is already there superintending the location of piers for the instruments. It was originally intended to observe at Philippeville, as Bona is occupied by two American parties, but the French Government would not give the necessary authorisation.

THE official party of the British Association, consisting of the president-elect and general and sectional officers, as well as other leading representatives of science, left Southampton on Saturday last by the mail steamer *Saxon* to attend the meeting of the association in South Africa.

DR. A. C. HOUSTON has been appointed director of water examinations under the Metropolitan Water Board.

THE death is announced, at the age of forty-six years, of Mr. H. Lamb, of Maidstone, author of "The Flora of Maidstone."

A REUTER telegram from Halifax, Nova Scotia, states that the Arctic exploration steamer, the *Roosevelt*, sailed from Sydney, Nova Scotia, on July 26. Commander Peary said he hopes to succeed in reaching the Pole, if not early in 1906, then the next year. He proposes to start on his final dash for the Pole from the eighty-fourth parallel.

ACCORDING to the *British Medical Journal*, a new society has been started in Paris for the scientific study of tuber-

culosis. The work of the society is to be purely scientific. The membership is restricted to thirty members, who are to be chosen irrespective of school or opinion, and there is to be no president. The members are in turn to preside at the meetings.

At the opening meeting of the council of the Liverpool Institute of Tropical Research, held on Monday, Sir Alfred Jones, the chairman, remarked that in many respects countries such as Germany, France, and Belgium are applying scientific methods to their commercial enterprises, especially to those conducted in the tropics, with greater success than Great Britain; and that it is necessary for the British merchant to bestir himself and take advantage of every assistance that science can offer. He guaranteed the institute 1000*l.* a year for four years; and among other guarantees were:—Mr. W. H. Lever, 1000*l.* a year for four years; Mr. T. Sutton Timmis, 250*l.* a year. It is proposed to take steps to obtain a charter of incorporation for the institute.

The tenth session of the International Statistical Institute was opened on Monday by the Prince of Wales, as honorary president of the institute, and of the Royal Statistical Society. In the course of his address, the Prince said:—"My revered grandfather, the late Prince Consort, who did so much for the progress of science, was instrumental in rendering special assistance to the first effort of statistical science to secure for itself an assured and prominent position in the ranks of the older and better recognised sciences. Quetelet, whose name stands preeminent in that science, was at one time the Prince Consort's mathematical teacher, and later on his close personal friend. It was on the occasion of our great exhibition of 1851 that a large and distinguished company of statisticians was assembled in London. It was chiefly at the instigation of Quetelet that the question of instituting periodical international congresses for the discussion of questions of common interest and international concern was proposed. In consequence of this proposal an international organisation was formed, and the first international statistical congress was held in Brussels in 1853. Later on, in 1860, London welcomed the international congress, which met under the presidency of the Prince Consort, who, in his opening address, remarked:—'The importance of these international congresses cannot be overrated. They not only awaken public attention to the value of these pursuits by bringing together men of all countries who devote their lives to this work, and who are thus enabled to exchange their thoughts and varied experiences. They also pave the way to an agreement among different Governments and nations to follow up these common inquiries in a common spirit, by a common method and for a common end.' This watchword of the congress of 1860 I would endeavour to commend to the congress of 1905 as worthily embodying its aims and its objects. National and social tendencies are to-day capable of increasingly accurate measurement with the aid of the very numerous statistical tabulations which now exist. In the future all branches of social science must look for their advancement and increase of precision to the continually improving character of the raw material furnished them by statisticians. For scientific progress, however, a primary essential is active and effective cooperation among scientific workers in all countries in order that publicity can be given to their results and uniformity obtained in the collection and arrangement of data for the purpose of their common employment."

The first number of a periodical for the publication of original investigations in economic biology will appear on September 29. The new magazine will be entitled the *Journal of Economic Biology*, and will be edited by Mr. W. E. Collinge, with the cooperation of Prof. A. H. R. Buller, Prof. G. H. Carpenter, Mr. R. Newstead, and Mr. A. E. Shipley, F.R.S.

Nos. 1 and 2 of vol. xxvi. of Notes from the Leyden Museum are entirely occupied by a memoir by Dr. O. Finsch on the birds collected by Dr. A. W. Nieuwenhuis in Dutch Borneo, more especially in the districts of Mahakam and Kajan. No less than 209 species were represented in the collection. The paper is illustrated with a coloured plate of the new species *Poliolophus nieuwenhuisi*, as well as with a map of the districts traversed by the explorer.

The most generally interesting item in the June number of the *Victorian Naturalist* is the description by Mr. J. A. Hill of fights between two species of ants. One of the two is the large soldier-ant (*Formica purpurea*), a species which forms huge nests, and is capable of overpowering such creatures as small snakes. Nevertheless, this species is vanquished and exterminated by a small black ant scarcely one-third its size, the battles between the two often lasting months, and the victors finally taking possession of the nests of the vanquished.

At the annual meeting held in May last of the Boston Society of Natural History, the curator of the museum reported (*Proceedings*, vol. xxxii., No. 5) that the plan for re-arranging the collections referred to at the previous meeting had been in great measure carried out, and that the New England mammals and birds now occupy all the cases on the main floor of the building with the exception of one temporarily devoted to the palæontology of the district. This special attention to the proper display of the local fauna is a feature which should be copied by all provincial museums.

The July number of the *Zoologist* contains a full report of a lecture on the migration of birds delivered at the recent International Ornithological Congress by Mr. Otto Herman, director of the Hungarian Central Office of Ornithology. The lecturer directed special attention to work which had been accomplished in Hungary in the matter of recording the dates of arrival and departure of migratory species by means of the services of a very large number of observers scattered all over the country. It has been ascertained, for example, that it takes one hundred and five days for swallows to complete their migration throughout Europe, that is to say, from Gibraltar in the south to Lulea in the north, the young being fully fledged in the former locality by the time the old birds have reached the latter. Even in Hungary itself the period of arrival may last as long as seventy days, the time that the species spends in that country averaging one hundred and sixty-seven days.

In recording a collection of fishes obtained by Dr. B. Dean from Negros Island, Philippines, Messrs. Jordan and Seale (*Proc. U.S. Nat. Mus.*, No. 1407) take occasion to mention that a large percentage of the small species, so often neglected by collectors, appear to be new. Taken generally, the Philippine fish fauna seems to be very similar to that of the Indo-Malayan archipelago, although a few species are identical with Indian forms. In the course of their list the authors give an example of one of those transpositions of generic names which are so hostile to the real progress of zoology. In this particular

instance the name Amia, so universally in use for the American bow-fin, is employed to designate the perch-like fishes commonly known as Apogon.

WE have recently received five parts of the *Proceedings of the U.S. National Museum*. In the first of these (No. 1408) Mr. T. Gill contributes the results of investigations into the life-history of the sea-horses (Hippocampus), a subject which has hitherto received but little attention. One of the illustrations shows a male discharging the young from its brood-pouch. In the second (No. 1409) Mr. B. A. Bean describes and figures an adult specimen of the extraordinary Japanese goblin-shark (*Mitsukurina owstoni*). The third (No. 1411) contains a list, by Mr. H. C. Oberholser, of birds collected by the well known traveller Dr. W. L. Abbott in the Kilimanjaro district, several of which are described as new. A descriptive list of a collection of caterpillars and chrysalises of Japanese Lepidoptera, by Mr. H. G. Dyar, constitutes the fourth fasciculus (No. 1412); while in the fifth (No. 1413) Mr. W. H. Asmead records Hymenoptera new to the Philippine fauna, with descriptions of new species.

PROF. A. GIARD, of the Sorbonne, has favoured us with separate copies of three articles by himself from vol. xxxix. of the *Bulletin scientifique de la France et de la Belgique*. In the first of these, entitled "Pœcilogonie," the author discusses whether in the case of organisms of which the adults are more or less similar to one another, while their embryogeny is different, more importance should be attached to the evolutionary dissimilarities or to the similarity of the adults. The title for the phenomenon is new. The second paper will delight the hearts of lovers of the oyster, the author remarking at the conclusion of this communication, which is entitled "La Prétendue Nocivité des Huîtres," that he "could wish there existed in the world no other cases of typhoid save those induced by eating tainted oysters." In the third communication Prof. Giard discusses the drift (*tendance*) of modern morphology and its relations to other sciences.

A PAPER on the development of the ascus and on spore formation in the Ascomycetes, by Mr. J. H. Faull, published as vol. xxxii., No. 4, of the *Proceedings of the Boston Society of Natural History*, gives a detailed description of the nuclear changes for *Neotiella albocincta*, *Sordaria fimicola*, and a species of Hydnobolites. The origin of the asci was in most cases traced to the penultimate or terminal cells of ascogenous hyphæ, and it was found that the uninucleate stage of the young ascus was always preceded by a fusion of two nuclei. From his observations of the method by which the spores are delimited, the author favours the view that the ascus is homologous with a zoosporangium, and would derive the Ascomycetes from such a group as the Peronosporeæ or Saprolegnieæ.

IN a paper forming No. 1405 of the *Proceedings of the U.S. National Museum*, Mr. R. MacFarlane, the chief-factor of the Hudson Bay Company, contributes a series of highly interesting notes on mammals collected and observed in the northern Mackenzie River district, North-Western Territories of Canada. For two-and-forty years (1852–1894) Mr. MacFarlane was stationed as a post and district manager in these territories, and therefore had unrivalled opportunities for observing the fauna in its days of abundance. Unfortunately, as he himself confesses, except when stationed at Fort Anderson the author did not take full advantage of these opportunities either in the matter of collecting or observing; nevertheless, such observations as have been recorded are of the highest interest and value, and one cannot help regretting that they were not published in a British or colonial serial, and also that the author's services were not long ago enlisted on behalf of the British Museum. The paper was, indeed, it appears, prepared to a great extent for publication at Cumberland House, the headquarters of Cumberland District, in the winter of 1890–1, but for various reasons it was not completed, and several sheets of the MS., together with various memoranda, were subsequently lost. The paper is a perfect mine of information with regard to the fur exports of the Hudson Bay Company in the old days.

TWO memoirs have lately been published by the Carnegie Institution of Washington which contain results of interest in reference to problems of heredity. The first of these, by W. E. Castle, discusses the phenomena of coat characters in guinea-pigs and rabbits. Three alternative pairs of coat characters in guinea-pigs are shown to conform generally to Mendel's law. These are:—albinism *v.* pigmentation, smooth *v.* rough coat, and long *v.* short coat, the first named in each pair of characters being recessive with respect to the second. The author distinguishes between characters which are recessive and those which are latent; by the latter he means certain "dominant" features which depart from Mendel's law in being capable of renewed activity under certain conditions even in "recessive" gametes. The facts given in the paper supply abundant illustrations of the variety of conditions under which blended inheritance, as in Mendel's Hieracium experiments, may occur in place of the strict Mendelian segregation. In the second paper, which is by D. T. Macdougal, assisted by A. M. Vail, G. H. Shull, and J. K. Small, a full account is given of the various forms of Œnothera which have constituted the chief material for De Vries's "mutation" theory, and of the relation between them. It is shown that *O. lamarckiana* is in all probability a true and independent species native to America; and the authors record the re-discovery of the habitat of *O. grandiflora*, the place of habitat of which in the American flora had become doubtful. Both memoirs are well illustrated by woodcuts and half-tone plates.

DR. H. MIGLIORATO announces in vol. ii., part ii., of *Annali di Botanica* that he is preparing an analytical dictionary of vegetable teratology as a subsidiary work to Penzig's "Pflanzen Teratologie," and requests that workers in this subject will cooperate by sending copies of their papers to him at 89b rue Panisperna, Rome.

PROF. F. W. OLIVER, in an article in the *Biologisches Centralblatt* (June 12) on the newly discovered seeds of the Carboniferous ferns, summarises the results of recent investigations in fossil botany which have led to the formation of a separate group, the Pteridospermeæ, including the Lyginodendreæ and Medullosæ. The paper is illustrated with figures of sections and a model of the seed in its cupule of *Lagenostoma Lomaxi*.

WE have received from Brazil the first number of the *Revista da Sociedade Scientifica de São Paulo*. It contains the first instalment of a report, written in French, of a voyage made in 1825 by Hercules Florence from the Tiete to the Amazon by the Brazilian provinces of St. Paul, Matto Grosso, and Gran Para. There is also a valuable memoir on the Brazilian Tabanidæ, written in German, by Dr. A. Lutz, director of the bacteriological institute of the State of São Paulo. Lastly there is a paper, written in Portuguese, by Erasmo Braga, on the gold mines of Ophir.

THE seeding of pastures is a matter of primary importance to owners of grazing land, and it is certain that many farmers will obtain useful information from the experiments conducted under the direction of Mr. A. N. M'Alpine, which are described in Bulletin No. 31 of the West of Scotland Agricultural College. Fourteen different mixtures were tried, three containing rye-grass in excess, three without rye-grass, and four were special mixtures; of the latter Timothy and cock's-foot mixtures in suitable quantity were especially efficacious in checking Yorkshire fog and bent grass. With respect to rye-grass, it was demonstrated that both the perennial and the Italian varieties should be sparingly sown.

THE cultivation of oranges in Dominica is discussed by Mr. H. Hesketh Bell in No. 37 of the pamphlet series issued by the Imperial Department of Agriculture for the West Indies. Mr. Hesketh Bell has been growing oranges for some years on two experimental stations, and has shipped sample boxes at different times to England which have realised remunerative prices at Covent Garden. Experience has proved that budded oranges are much superior to seedlings, and the varieties "Parson Brown" and "Jaffa" are recommended as being hardy and prolific, while the "Washington Navel" also appears to thrive well. Emphasis is laid on the necessity for exercising the greatest care in handling and packing the fruit, so that Dominica brands may secure a good name on the market.

THE banana industry was unknown to Costa Rica twenty-five years ago, says a writer in the *Journal of the Society of Arts* (July 28), but it has reached such proportions, especially within the last few years, that bananas now form the main export of the country. At the close of 1904, about 50,000 acres were devoted to banana growing in Costa Rica. The trade was exclusively confined to the United States until 1902, when the fruit was exported to England, with gratifying results. France, Germany, Italy, Spain, and other European countries do not as yet consume the banana, but as soon as a substantial increase in the acreage is reached, and with the present facilities for transportation and the use of ships equipped with cold storage, the market will be extended probably to those countries. The amount exported from Port Limon during the five years ended with June 30, 1904, was as follows, in bunches:—1900, 2,804,103; 1901, 3,192,104; 1902, 4,427,024; 1903, 5,261,600; and 1904, 5,760,000. The following figures show the probable cost and profit on a tract of 100 acres planted in bananas. Original outlay:—land (4*l.* per acre), 400*l.*; reducing land and bringing it to a banana-bearing condition (10*l.* per acre), 1000*l.*; total, 1400*l.* Gross returns, 180 stems per acre per annum, 1116*l.* Expenses:—cutting and hauling the fruit, and keeping the plantation clean, 288*l.*, manager (20*l.* per month), 240*l.*; total, 528*l.* Net return on investment, 588*l.* Under favourable conditions, a banana plant may give a stem of fruit in nine months, but it generally takes from fifteen to eighteen months for the average plantation to be in full bearing. The life of a plantation varies according to the fertility of its soil and topographical situation. Some soils may need a rest in six or seven years, while others may last practically for ever, as in cases where periodically enriched by alluvial deposits. It is understood that fine flour can be made from bananas, and that fibres from the leaves and stalks could be extracted and successfully worked, but as yet nothing in this direction has been done in Costa Rica.

THE *Engineering and Mining Journal* directs attention to the increasing tendency to use copper as the collecting agent instead of lead in smelting gold and silver ores. Smelting on the copper basis is decidedly cheaper than on the lead basis.

WE have received part i. of the annual report of the director of the Philippine Weather Bureau for the year 1903, containing hourly observations of atmospheric phenomena at the Manila Central Observatory. The assistant director contributes a useful climatological summary for the year, together with monthly and daily amounts of excessive rainfall that have occurred since 1865. Photographic illustrations are given of the havoc wrought by one of the two destructive cyclones which traversed the archipelago. Unfortunately, there was no good anemometer at any of the towns that suffered most severely. Manila itself escaped these violent storms.

THE Hamburg Meteorological Institute has issued vol. xiii. of "Deutsche überseeische meteorologische Beobachtungen," 1905. As may be inferred from the title, the work contains observations made at places abroad, under German control. In the present case it refers entirely to some twenty-two stations in German East Africa, and the tables have been prepared and printed with the liberal assistance of the Colonial Department of the German Foreign Office. It contains more than 300 pages of valuable observations, and is a very important contribution to the climatology of Africa, with explanatory details relating to each of the stations. For some of them hourly observations are given from self-recording instruments; at others eye observations have been made several times daily.

A PAPER entitled "Records of Differences of Temperature between McGill College Observatory and the Top of Mount Royal, Montreal," by Prof. C. McLeod, was read at the meeting of the Royal Society on June 8. The chief object of the paper was to show the advantage of Prof. Callendar's electrical recorders, in connection with the use of platinum thermometers, in obtaining trustworthy indications of the variations of temperature at a distance in a situation inaccessible for the greater part of the winter. The horizontal distance between the stations was 3300 feet, and the difference of altitude 620 feet. The first year's working (July, 1903, to May, 1904) showed that range of variation was considerable, and often changed very rapidly; on some occasions the temperature at the higher station was 6° F. or 7° F. above the lower, on others it was 25° below. A comparison of the records showed that any marked change of temperature at the lower station was almost invariably preceded by a similar change at the higher station at an interval of twelve to twenty-four hours. It is claimed, we think with fairness, that this system of recording meteorological data appears to overcome the difficulty and expense of maintaining a staff of observers at an inaccessible station.

AT the last annual meeting of the Royal Meteorological Society, the president, Captain D. Wilson Barker, gave an interesting address, illustrated by a number of lantern slides, on the connection of meteorology with other sciences. He pointed out several of the most evident influences of meteorology to the geological observer, such as rain, ice, snow, &c., and the rock-splitting action of great changes of temperature. As regards zoology, the influence of meteorology on animal life is all-pervading. Among the most common results are mentioned the winter sleep of various animals, and the summer sleep of some fishes and

reptiles. Dr. Dickson, Dr. Mill and others are studying the effects of changes of climate on sea organisms generally. Agriculturists are more dependent on the weather than any other class of persons. Were it possible to issue forecasts for a longer period in advance, farmers would be much benefited. Captain Barker considers that the effect of weather upon health has not received a fair amount of scientific notice. While medical officers write voluminous reports on the public health, many of them ignore the meteorological conditions of the districts under review. We think we are justified in claiming exception for the reports of the various registrars-general, which contain carefully prepared meteorological statistics.

IN the *Rendiconti* of the Lombardy Academy, xxxviii., 2, Prof. Ernesto Pascal gives a classification of the various forms of twisted sextic formed by the intersection of a quadric and a cubic, with special reference to the number of their real tritangent planes.

WE have received the third edition of Dr. Richard Dedekind's pamphlet on "Stetigkeit und irrationale Zahlen," which may now fairly claim a place among the mathematical classics. It originated about the year 1858, when the author was charged with a course of lectures on the calculus, and found no satisfactory treatment of the continuity hypothesis in existence. On November 24, 1858, Dedekind discovered a definition of continuity which he imparted to Durège a few days later, and the present pamphlet was written in 1872 in commemoration of his father's jubilee.

IN the Bulletin of the American Mathematical Society for June, Dr. Edward Kasner directs attention to a significant dialogue in Galileo's "Discorsi e dimostrazioni mathemetiche" of 1638, in which modern concepts of infinity as laid down by Bolzano, Cantor, and Dedekind appear to have been foreseen by that philosopher. In this dialogue Salviati points out to Simplicio that since every number has a square there must be as many squares as there are numbers, but, on the other hand, since there are many numbers which are not squares there must be more numbers than squares. In answer to Simplicio's question "What is to be our conclusion?" Salviati gives the following remarkable reply:—"I see no escape except to say: the totality of numbers is infinite, the totality of squares is infinite, the totality of roots is infinite; the multitude of squares is not less than the multitude of numbers, neither is the one greater than the other; and, finally, the attributes of equal, greater and less are not applicable to infinite but solely to finite quantities."

MR. J. J. HICKS, of Hatton Garden, has submitted a two-foot rule designed by Mr. Scott which is worthy of notice. When opened out like an ordinary carpenter's rule one face shows inches and sixteenths along one edge and millimetres along the other, while between them the divisions are repeated in juxtaposition for the purpose of more accurate comparison. It is the other face of the rule, however, where the greater novelty is to be found. Here there are four double comparison scales of English and French measures of length, weight, capacity, and fluid measure. Taking the first as an example of the system, a length of about 10 inches shows comparison quantities from 1 inch to 60 miles juxtaposed, but the divisions are not equispaced, as in that case nothing much less than a mile would be visible. They are therefore spaced logarithmically, so that the first inch covers a space of nearly half an inch. This is divided into eighths, and each of these by estimation could be read to tenths. The next two inches occupy the same space, and so, of course, do the next four, and so on. In a distance of $1\frac{1}{2}$ inch or 38 millimetres, a reading is increased ten-fold. Of course such comparison scales have the advantage of the ordinary slide rule that at all parts of the scale readings are made with the same proportional accuracy. For instance, on the scale now referred to 1 inch is opposite 25 and a small half-millimetre, $11\frac{1}{2}$ yards is opposite $10\frac{1}{2}$ metres, 5 miles is half the thickness of the line beyond 8 kilometres, and similarly 50 beyond 80. In short, the accuracy with which any of these comparison scales may be read is the same as that which would apply to a slide rule in which the A line from 1 . . . 100 was 3 inches long. For quick and fairly accurate comparison of lengths, weights, cubic and fluid measures, this face of the rule is most convenient.

WE have received several papers dealing with projects (not performances) of artificial flight the general character of which is sufficiently shown by the following brief summaries:—Arnold Samuelson, in a lecture published at Hamburg (London: E. and F. N. Spon), asserts that all flying animals (insects and birds) have flat, not curved, wing surfaces, that the normal air-pressure on a thin supporting plane is independent of the angle of incidence at which the plane moves forward, that the pressure on a rectangular plane decreases uniformly from front to back, giving a centre of pressure at one-third the distance from the front to the back surface, and other conclusions equally at variance with many generally accepted theories. Dr. Federico Sacco, in a paper entitled "L'Aerovoie" (Turin: P. Gerboni), proposes a captive balloon attached to a small trolley running along a kind of elevated cable railway as a cheap and rapid means of locomotion which would be unaffected by such trifling terrestrial obstacles as rivers, mountains and lakes; in windy weather a voyage on such an apparatus would doubtless be highly thrilling. For the argument of cheapness Dr. Sacco is responsible. M. René de Saussure, writing in the *Revue scientifique* for May 27, describes the "hélicoptère aéroplane" of MM. H. and A. Dufaux, which, roughly speaking, consists of a pair of double-surface gliders placed fore and aft, with two screw propellers arranged side by side between them rather nearer to the front than to the back gliders. Of this apparatus only small models have been tried, and a large sized machine 8 metres long and 3 metres broad which has been constructed has not yet been experimented on; the authors, however, give full details as to how to start the machine and to land safely. The latter operation, as shown in the diagram accompanying the article, bears a rather ominous resemblance to the motion of a dynamically unstable glider previous to capsising. We cannot close the list without referring to a paper by Mr. F. W. H. Hutchinson, read at Cambridge and published in *Knowledge and Scientific News* for June, describing experiments on models with bird-like wings, which have already yielded some interesting results in the study of natural flight. The wings in this case were not assumed to be flat, but of the curved form, which the author describes as the "Hargreave curve."

MESSRS. WITHERBY AND CO. have issued the prospectus of a book on "The Birds of Hampshire and the Isle of Wight" which they have in preparation. The work is by the Rev. J. E. Kelsall and P. W. Munn, and is claimed to be the first complete history of the birds of Hampshire and the Isle of Wight published. The work will contain a large-scale coloured map, and be illustrated by reproductions of drawings and photographs.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF JUPITER'S GREAT RED SPOT.—In No. 4034 of the *Astronomische Nachrichten* Mr. Stanley Williams gives the results of the observations of the Great Red Spot on Jupiter made by him during the period June 20, 1904–January 21, 1905.

During this opposition the phenomena proved of exceptional interest on account of the vagaries in the relative motions of the Red Spot and its immediately surrounding features.

When the first observation was made, on June 20, it was seen that the immense mass of dark material, known as the south tropical disturbance, had, after making a complete circuit of the planet, again overtaken and enveloped the Red Spot. On July 26 nearly all this dark material had drifted past the Red Spot, which in August was quite separate, but very faint.

Mr. Williams's observations also afforded further evidence of the variable rate of motion of the Great Red Spot.

SUN-SPOT SPECTRA.—During the year ended March, 1905, Mr. W. M. Mitchell, of the Princeton Observatory (N.J.), made an exhaustive series of observations of that part of the sun-spot spectrum which is included between F and α. These observations took note of the two separate features of the spot spectrum:—(1) the nearly continuous absorption known as the spot-band, and (2) the affected Fraunhofer lines. A rapid survey of the whole region was first made on each observing day, and was followed by an exhaustive examination of some smaller portion. In regard to the first of the above features, Mr. Mitchell arrived at the conclusion that the band-lines are lines which do not appear in the Fraunhoferic spectrum at all, and he submits facts in favour of this view.

In observing the affected Fraunhoferic lines, the observer recorded nine different phenomena (*e.g.* widening, reversal, obliteration, &c.), and in his table of the 680 lines which he observed in the spot spectrum, he classifies each line according to the manner in which it was affected. The intensities of the widened lines, their intensities in the normal solar spectrum, the number of times each line was observed, and various other details concerning the affected lines are also recorded in the table.

Each element involved is then considered separately, and a number of valuable conclusions are deduced. Whilst vanadium and titanium are the most important elements concerned in sun-spots, as previously shown by Young, Cortie, and Lockyer, Mr. Mitchell finds that manganese plays an important *rôle*, 45 per cent. of its lines being affected. A striking comparison is drawn between the behaviour of certain manganese lines in the successive observations of the great sun-spot of February last. On February 3 and 4 they were noted as being strongly reversed, whereas on March 3 they were no longer reversed, but were excessively widened and very hazy.

The following general conclusions were arrived at by Mr. Mitchell, and agree, in general, with those recently published by Prof. Fowler in the Monthly Notices:—(1) Lines frequently seen in the chromosphere are, with two exceptions, but little affected in spots; (2) high-level chromospheric lines are not affected in spots; (3) lines greatly affected in spots are seen but rarely in the chromosphere.

From his observations and conclusions Mr. Mitchell deduces that sun-spots are, at least, below the chromosphere, and are probably caused by the heated vapours from the lower levels oozing through and vaporising the clouds of the photosphere (*Astrophysical Journal*, No. 1, vol. xxii.).

AN INTERESTING ASTEROID, OCCLO [475].—Owing to its large southerly declination, $-62°$, at the time of its discovery, the minor planet Occlo was looked upon as of special interest, and when the orbit was computed and found to have a greater eccentricity than that of any other known asteroid the interest in this object was increased. This great eccentricity suggested that Occlo might be looked upon as the connecting link between the asteroids and the periodic comets. In order that the object should not be lost sight of, Prof. Kreutz had an ephemeris for 1905 computed, and this was communicated to Mr. R. H. Frost at Arequipa, who successfully photographed the planet's trail, with the 24-inch Bruce telescope, in April, 1904. The plates have now been measured by Mrs. Fleming, and the positions of both ends of the trail on April 4 and on April 7 determined. The results are given in Circular No. 101 of the Harvard College Observatory.

OBSERVATIONS OF PHŒBE.—Saturn's ninth satellite, Phœbe, was photographed by Mr. R. H. Frost at Arequipa on four nights during May, and the following positions have been obtained from measurements of the plates:—

Date 1905	G.M.T. h. m.	Exp. m.	Dist.	Difference in decl.	Position angle
May 9	21 3	112	10′·6	+5′·8	56°·8
,, 10	20 40	120	11·0	+6·4	54·4
,, 12	20 49	120	11·6	+6·3	57·1
,, 13	20 48	145	12·0	+6·6	56·6

The above quantities all refer to the position of the satellite in regard to Saturn's centre. A comparison of these positions with those computed from Dr. Ross's ephemeris shows that on the mean date, May 11, the computed distances should be diminished by 0′·3, and the position-angles should be increased by 0°·0 (Harvard College Observatory Circular, No. 102).

PERIODS OF THE VARIABLE STARS S SAGITTÆ AND Y OPHIUCHI.—From a discussion of the observations made by himself, combined with those of other observers, M. M. Luizet has deduced the following elements for the light-curve of the variable star S Sagittæ (Ch. 7149):—

$$\left.\begin{array}{l}\text{Maximum } 2409863{\cdot}33 \text{ (M.T. Paris)} \\ \text{Minimum } 2409860{\cdot}37 \quad\quad ,,\end{array}\right\} + 8{\cdot}38209\text{d. (E.} - 389)$$

The light-curve of this star presents a double oscillation, and, according to M. Luizet's scale, the magnitude varies between 5·4 and 6·2.

For Y Ophiuchi (Ch. 6404), the same observer finds that M. Hisgen's elements,

$$\left.\begin{array}{l}\text{Maximum } 2408694{\cdot}25 \text{ (G.M.T.)} \\ \text{Minimum } 2408688{\cdot}03 \quad\quad ,,\end{array}\right\} + 17{\cdot}1207\text{d. E.},$$

as published in No. 3424 of the *Astronomische Nachrichten*, agree very well with his own recent observations. From a comparison of these observations with those made by Mr. Sawyer, it appears that during the last fifteen years the magnitude of Y Ophiuchi has slightly increased, but this apparent increase may be due to the difference of observer and of observing conditions (*Astronomische Nachrichten*, No. 4030).

THE MEETING OF THE BRITISH MEDICAL ASSOCIATION.

THE seventy-third annual meeting of the British Medical Association was held at Leicester last week under the presidency of Mr. Cooper Franklin, surgeon to the Leicester Infirmary. The proceedings were conducted in twelve sections, and were well attended, nearly 1000 members registering their names.

Mr. Cooper Franklin chose for his presidential address the subject of medical education, past, present, and future. He dealt with the various Acts of Parliament regulating medical education and practice, the condition of medical education in London forty years ago, and insisted on the necessity of a good general education if the medical student were to become a good practitioner, and advocated a study of Latin and Greek. He said:—"I think the advantages of a good classical education early, to a man entering our profession, cannot be over-rated. Nothing will, or can, make up for it; there would not be so many candidates deficient in ordinary spelling and composition if there had been a good classical education. To my mind there is nothing really superior to the old-fashioned Latin and Greek training, but it seems hopeless to insist nowadays upon the retention of Greek. I think it is twenty-five or thirty years ago since, in the matriculation examination of the University of London, students were allowed to take up German instead of Greek. I venture to think that, so far as medical students are concerned, that was a retrograde step. I do not envy the student sitting down to learn his anatomy who has not learnt even a little Latin

and Greek; his Gray's 'Anatomy,' perchance, in front of him, his Latin dictionary on one side, and his Greek lexicon on the other. The student, too, must not begin to specialise too soon; he wants a liberal education, an education for its own sake. This goes when the technical education begins—that is, when he leaves school or college to learn to be a 'doctor.'"

Dr. Henry Maudsley delivered an address on medicine, present and prospective, in which he discussed preventive medicine, heredity in disease, &c. He sounded a note of warning with regard to our present sanatorium treatment of tuberculosis which may be quoted:—"But is phthisis so very curable in these special hospitals, nowise endued with any special grace, I imagine, by reason of their being called sanatoriums? Adequate statistics are not yet available, but thus far the modest outcome of experience seems to be that many patients who are sent in the early stage of the disease recover, if they are kept long enough; that most of those in a more advanced stage improve while there, frequently relapsing afterwards; and that those who are badly diseased ought not to be sent at all. Is that, after all, to say much more than might be said of sensible treatment before the erection of sanatoriums?

"Can we, again, eliminate the predisposing influence of heredity? Actual tubercle may not be inherited, but the poor constitutional soil inviting and suiting the bacillus still passes from parent to child; and we do not get rid of the essential fact by changing the name. Do we, indeed, in the end get such a valuable addition to the life-capital of the nation? It is easy enough, noting that some 60,000 consumptives die annually in England and Wales—I do not vouch for the figures—fancifully to rate the value of each life at an arbitrary figure and then by multiplication to make an appalling computation of the loss to the community; but is the loss so real? Might not the ultimate cost to the commonwealth be greater were these persons to go on living and breeding in it? An addition to the nation's life-capital is all very well, but the quality of the capital counts for a good deal, and it will not count for much if it is not realisable. What does the realisation amount to in practice? The patient who comes out of the sanatorium recovered or improved must usually go back to his former work and surroundings; he cannot adapt the world to the weakness of his nature and its ideal needs, but, like other mortals, must adapt himself to the rude world and perforce do much as they do. That is what he quite naturally does; returns to his work and his old ways, perhaps gets married if he is not married, and begets children who can hardly have the confidence of a good descent. Meanwhile, when he relapses, he sows bacilli broadcast, thus multiplying such life-capital to fulfil its ordained function in the universe, that apparently being to make away with weak mortality."

The address in surgery by Mr. C. J. Bond, surgeon to the Leicester Infirmary, dealt with ascending currents in mucous canals and gland ducts. The results of a number of experiments proved that by some means or other, and under certain conditions, particles of an insoluble substance, such as indigo, inserted into the orifices of a mucous canal or duct are conveyed along the mucous channel in a reverse direction to that taken by the contents of the tube, or by the secretion or excretion of the glands along such ducts. The conditions which seem to favour this passage are—some interference with the normal flow of the contents of the mucous tube or duct; some arrest or diversion of secretion, such as is produced by a fistulous opening, though it is by no means necessary that this should be complete.

In the section of medicine an interesting discussion on the treatment of sleeplessness was opened by Sir Lauder Brunton. Many of the speakers dwelt on the importance of indigestion and of high arterial tension in inducing sleeplessness, and Dr. Collier (Oxford) considered that much of the present day insomnia might be referred to over-education, especially in preparing for scholarships, the successful competitors often suffering after the age of nineteen years from nervous failure and insomnia. He thought that the occasional employment of narcotics was of value in breaking a vicious circle before the habit of sleeplessness was established.

In the section of State medicine an important discussion on hospital isolation was introduced by Dr. George Wilson (Warwick), who stated that the deductions he would bring forward were the outcome of thirty-two years' experience. With regard to small-pox isolation, he contended for a special block at the general infectious hospital, and, in his opinion, there was very little risk of the spread of infection. With regard to scarlet fever, he stated that hospital isolation had failed in reducing the incidence and mortality of the disease. He was also sure that it did not cause the presence of the milder form of the infection, and was strongly in favour of separate isolation rather than aggregation in large wards.

Several speakers considered that hospital isolation for scarlet fever was a failure, and a resolution was adopted requesting an inquiry by the Local Government Board into the subject.

In the section of industrial hygiene the subject of physical deterioration naturally attracted a good deal of attention, and an important discussion was introduced by Dr. Dawson Williams (London), who, by means of several tables illustrating a series of observations on the height and weight of boys in primary schools, showed that after the eighth year of age the weight of boys of the artisan classes was very much below the average, this fact being more noticeable in the lowest grade schools. The same remarks applied to the height of boys, though in a less degree. The first striking statement about physical degeneration was made some years ago by Mr. J. Cantlie, who challenged any person to produce a Londoner of the fourth generation. This challenge had never been answered. Dr. Dawson Williams attributed this physical deterioration to various causes, among which he mentioned—improper feeding in infancy; the fact that among the poorer classes mothers worked hard almost up to the time of their confinement; intemperance in fathers, which was said by French authorities to be more injurious to the children than maternal intemperance; and the practice of large numbers of children in London sitting out of doors until midnight, which involved a great expenditure of nervous energy.

Mr. William Hall (Leeds), in a paper on the influence of environment on physical development, said that fifty years ago the slum mother was much more sober, cleanly, and domestic than she was to-day. She was better nourished herself, always suckled her children, and after weaning them gave them nutritious bone-making food, which she prepared at home. This had all been done away with by our elaborate education system, costing 20,000,000*l.* yearly. Children were now fed on cheap stale food, well seasoned with condiments, which educated them for the love of stimulants in later life and produced also a tendency to scurvy, rickets, and purpura. A little while ago he had examined more than 100 adult skeletons in the crypt of Hythe Church, where they had lain for several centuries. He was struck by the fact that the bones were small but not rickety, the bony palates not much vaulted and the alveolar arches regular, and the teeth that remained were good. It had been said truly that there were hundreds and thousands of our countrymen now living whose skeletons, if preserved, would some day show highly vaulted bony palates, contracted alveolar arches, anterior protrusion of the upper jaws, the remains of unsound teeth, and abundant general signs of rickety bony framework. It was remarkable that Jewish children in the slums were superior to Christian children in physical development, which was due to the fact that the pregnant Jewess was better cared for, that 90 per cent. of the infants were fed on breast-milk, and that during later childhood they were abundantly fed on bone-making material. Eggs and oil, fish, fresh vegetables, and fruit entered largely into their diet. Yet the Jews had not been taught to safeguard their pregnant wives and to nourish their growing children by the instructors in the modern and costly State education which they were told at Oxford was to be at the root of everything.

Prof. R. J. Anderson (Queen's College, Galway) remarked that he thought it would be a most important thing to secure a complete anthropometric survey of the whole of the British Isles. He doubted if improper food was the chief cause of physical deterioration, because, in his opinion, food had of late years greatly improved in quality.

Mr. W. D. Spanton (Leeds) considered that the most prominent causes of physical degeneration were—efforts to rear premature and diseased infants, absurd educational high pressure, cigarette smoking in the younger generation, and late hours at night; in fact, the love of pleasure, and ergophobia in all classes of society. He considered that there was too much cheap philanthropy, that life was made too easy for the young poor, and that by modern educational methods proper parental discipline was rendered almost impossible.

Mrs. F. M. Dickinson Berry (London) said that in her opinion children in London schools were not underfed so much as improperly fed, and that they preferred to eat bread and pickles, dried fish, &c., and had to be forced to eat a proper dinner. She quite endorsed Mr. Hall's remarks about Jewish children.

In the section of pathology, a discussion on the relationship of heredity to disease was opened by the president, Dr. Mott (London), in an interesting and suggestive paper. He exhibited charts of hereditary hæmophilia and ataxy with statistics of longevity, presenility, psychoses, and neuroses bearing on these and other diseases.

Mr. Charles Bond contributed a paper on sex-correlation and disease, with special reference to deaf-mutism. While deaf-mutism occurs almost equally in males and females, in any given family the incidence is almost limited to the members of one sex, and when members of both sexes in one family suffered the births were either twin or contiguous.

Mr. C. Hurst described experiments on the correlation of sex. When black and yellow cats were crossed, all male kittens were yellow, all female kittens tortoiseshell, but in the second generation the colours were uniformly distributed between the two sexes.

In the section of tropical diseases, an important paper on human tick fever in the Congo Free State by Dr. Todd and the late Mr. Everett Dutton was read. The conclusions arrived at were:—(1) that tick fever is clinically identical with relapsing fever, and has for a pathogenic agent a spirillum; (2) the spirillum is probably the *Spirochaete Obermeieri*; (3) a tick, the *Ornithodorus monbata*, can transmit the spirillum from animal to animal; (4) the transmission is probably not simply mechanical, but a developmental cycle is passed in the body of the tick.

In the naval and military section, Fleet-Surgeon Beadnell read an interesting paper on some dynamical and hydrodynamical effects of the modern small-bore bullet, in which he claimed that the so-called "explosive" effects of the modern bullet were due to sudden enlargement of the "impact area" resulting from a modification either in the form or in the motion of the projectile. Many of the "explosive" phenomena were due to eccentricities of flight such as the various "spinning-top" and "pirouetting" motions of the bullet.

An invitation to hold the annual meeting of the British Medical Association next year in Toronto was cordially accepted.

SOLAR AND TERRESTRIAL CHANGES.

IN a recent article we referred to the formation of an International Commission to deal with the important question of the possible action of solar changes on the earth's atmosphere. We stated that a meeting is to be held at Innsbruck in September. We are now enabled to give some details of the meeting at Cambridge last year.

The members assembled in the Old Library of Pembroke College on Thursday, August 18, and letters were read from the following:—Prof. H. H. Hildebrandsson, Prof. H. Mohn, General M. Rykatcheff, Prof. G. Hellmann, Dr. A. Paulsen, Hofrath J. M. Pernter, Prof. S. P. Langley, M. A. Angot, Prof. J. Violle, Prof. J. Hann, Mr. A. S. Steen, Prof. W. Köppen, Prof. A. Riccò, Prof. G. E. Hale, Prof. F. H. Bigelow, Mr. W. G. Davis, Prof. K. Ångström, Mr. A. R. Hinks.

The members present proceeded to the election of a president and secretary, and it was unanimously resolved that Sir Norman Lockyer, director of the Solar Physics Observatory, South Kensington, be elected president, and Sir John Eliot, of Bon Porto, Cavalaire, formerly meteorological reporter to the Government of India, secretary.

It was resolved to add the names of MM. Max Wolf, Scheiner, Julius, and Wolfer to the commission if they should be willing to serve.

At the next meeting the name of Sir Arthur Rücker was added to the commission.

The following question was considered:—

"(1) The selection of (*a*) meteorological, and (*b*) magnetic elements, which should be collated for the purpose of comparison with solar observations, and the form in which the observations might be presented with the greatest advantage for the purposes of comparison. The preparation of a list of meteorological and magnetic observatories which should be asked to contribute observations for the purpose."

It was resolved

(1) That, in the first instance, for the purpose of comparison with solar phenomena, the meteorological observations to be considered should be monthly means of pressure, rainfall and temperature (including maximum temperature and minimum temperature).

(2) That the members of the commission be requested to communicate to the secretary a short report on the data available in their respective countries, and the number of years over which they extend.

(3) That the members of the commission be requested to make suggestions with regard to additional stations from which it is desirable that data should be obtained in view of the comparison of solar and terrestrial data.

(4) That the secretary be requested to consult Dr. Chree as to the stations from which magnetic data are at present available, and to refer to a paper by Prof. von Bezold as to additional magnetic stations from which information is desirable, and to circulate the information among the members of the commission, it being understood that the data appropriate for the purposes of comparison are monthly means of the three magnetic elements for the quiet days and data as to magnetic storms.

A letter from Prof. Hale was laid before the commission.

At the third meeting the questions of the selection of meteorological stations and of the establishment of additional meteorological stations were again considered, and it was resolved that the members of the commission should hand in their list of selected stations to the secretary after the close of the British Association meeting, and that it would be desirable that observations should be obtained from two stations in the Pacific. The stations selected were Tahiti and Numea, to be established by the French Meteorological Bureau.

The name of Mr. A. L. Rotch was added to the commission.

The letter received from Prof. Hale suggesting cooperation of the commission with the committee on solar research of the National Academy of Sciences was read. It was resolved that the commission thank Prof. Hale for his letter, and express their desire to cooperate with the committee on solar research of the National Academy of Sciences on questions of common interest.

Mr. Rotch was requested to communicate this resolution personally to Prof. Hale at the conference at St. Louis.

The question of the selection of solar observations for the comparison of data was taken into consideration.

A scheme prepared by Messrs. Riccò and W. J. S. Lockyer was read and provisionally approved.

(1) *Suggested observations of the sun for direction, intensity, and amplitude of "boiling of the limb."*

Present observations:—

Twenty years' observations made in Palermo and Catania, and (?) many years' observations in Madrid.

(2) *Number, area, and position of spots.* Existing arrangements suffice.

(3) *For visual observations of prominences on limb, it is suggested that America or Japan be invited to contribute.* (Places widely separated in longitude required.)

Monthly values of the percentage frequency of prominences for every 5° of latitude north and south.

(4) *Sun-spot spectra.*

Available observations are taken at the Solar Physics Observatory, South Kensington; Poona in India; Stony-

hurst in England; and Kodaikanal in India; and are sufficient for the present.

(5) *Spectroheliograph.*

(1) "Discs" in "K" light { Kensington, Chicago, Kodaikanal, Catania (later).

(2) "Limb" in "K" light ditto.

At the fourth meeting further consideration was given to the question of the solar observations which it is desirable should be collected for the purposes of comparison.

(1) It was resolved, that in connection with the observations of solar radiation, observations of the transparency of the air should be made, more especially

(*a*) on the visibility of distant and high mountains when possible;

(*b*) photometrical observations of Polaris.

(2) It was resolved that a circular be addressed to the various meteorological organisations, asking them to send to the secretary for the purposes of the commission a copy of the publications of their offices embodying the data specified in resolution of August 19, and that the organisations be also requested to obtain and forward copies of similar publications from the colonies and dependencies of their respective countries.

(3) It was resolved that a circular should be sent in the following terms:—The commission desire to direct attention to the concluding paragraphs of Prof. Violle's report to the International Meteorological Committee 1903, and would be greatly obliged if the commission could be informed of the arrangements for observing solar radiation adopted at the observatories of the various meteorological organisations and the methods employed to render the observations comparable with those of other observatories.

(4) Mr. Shaw reported that an apparatus for recording solar radiation was in process of being established, and tested at the Cambridge Observatory, and that Mr. W. E. Wilson, of Daramona, who had presented the apparatus to the observatory, had promised a note upon the apparatus for the information of the commission.

At the fifth meeting the question of the magnetic observations for the purposes of comparison was taken into consideration.

It was resolved in connection therewith:—

That the establishment of magnetical observatories in about lat. 70° N. (*e.g.* Bosskop in Norway) and in very high latitudes of the southern hemisphere is of the highest importance for the advancement of science.

Prof. Riccò informed the commission that it is intended to establish in Italy or Sicily a magnetic observatory with self-recording instruments belonging to the Italian Meteorological Office.

The secretary was directed to ascertain from the members of the commission whether they consider it desirable that a meeting should be held at Innsbruck next year (1905).

It was also resolved that the secretary should report to the International Meteorological Committee the proceedings of the meetings of the commission held here, and ask that the proper steps be taken to bring before the International Association of Academies their suggestions relating to Government action.

Letters from Messrs. Bigelow and Davis were read. It was resolved that Prof. Pernter's letter should be translated and given in the proceedings.

Prof. Riccò informed the meeting that he had been charged by Prof. Rizzo to say that he will willingly undertake to carry out any investigation the commission may be pleased to entrust to him, and it was resolved that Prof. Rizzo should be thanked for his offer, and that a written communication be addressed to him later.

It was agreed that all communications for the commission should be received at a central address, viz. the Solar Physics Observatory, South Kensington.

It was further resolved that

The commission considers it is desirable that the data for the purposes of comparison should be sent to the president of the commission, South Kensington (Solar Physics Observatory), for tabulation and comparison. The commission attaches the greatest importance to this work, more especially as it may lead to a practical system of long-period forecasting, and hopes that if it be necessary, an increase of staff at that observatory may be authorised to bring all old observations up to date.

The commission, after a vote of thanks to the president, adjourned *sine die*.

The commission has circulated in the appendix to its report much valuable correspondence, but we have not space to refer to it.

With regard to the Innsbruck meeting, the following members of the commission are expected to be present:—M. A. Angot, Bureau Central Météorologique, Paris; Prof. H. J. Ångström, University, Upsala; Prof. F. H. Bigelow, Weather Bureau, Washington; Prof. Birkeland, University of Christiania; Rev. P. R. Cirera, S.J., Observatorio del Ebro, Tortosa, Spain; Dr. W. G. Davis, Oficina Meteorologica Argentina, Cordoba, Argentine Republic; M. Deslandres, Observatoire d'Astronomie Physique, Meudon, Seine et Oise; Sir John Eliot (secretary), 54 Prince of Wales Mansions, Prince of Wales Road, Battersea, and Bon Porto, Cavalaire, Var, France; Prof. G. E. Hale, 678 St. John Avenue, Pasadena, California, U.S.A.; Hofrat Prof. J. Hann, XIX Hohe Warte, Vienna; M. Janssen, Observatoire d'Astronomie Physique, Meudon, Seine et Oise; Prof. W. H. Julius, Rijks Universiteit, Utrecht, Holland; Prof. W. Köppen, Deutche Seewarte, Holland; Prof. S. P. Langley, secretary of the Smithsonian Institution, Washington; Sir Norman Lockyer (President), Solar Physics Observatory, South Kensington; Dr. W. J. S. Lockyer, Solar Physics Observatory, South Kensington; Hofrat Prof. J. M. Pernter, Hohe Warte, Vienna, Austria; Prof. Riccò, University de Catania, Sicily, Italy; Prof. G. B. Rizzo, University of Messina, Sicily, Italy; Prof. L. A. Rotch, Blue Hill Meteorological Observatory, Cambridge, Mass.; Sir Arthur Rücker, 19 Gledhow Gardens, S.W.; Prof. J. Scheiner, Königl. Friedrich Wilhelms Universität, Berlin; Dr. W. N. Shaw, Meteorological Office, 63 Victoria Street, Westminster; Prof. A. Steen, Meteorological Institute, Christiania; Prof. J. Violle, Conservatoire des Arts et Métiers, Paris; Prof. C. H. Wind, University of Utrecht, Holland; Prof. A. Woeikoff, St. Petersburg, Russia; Herrn Prof. Max Wolf, Grossherz Ruprecht-Karls Universität, Heidelberg, Germany; Prof. A. Wölfer, Zurich Observatory, Switzerland.

THE TEACHING OF PRACTICAL CHEMISTRY AND PHYSICS.[1]

DR. FISCHER has set himself the almost limitless task of describing and comparing the various methods of science teaching adopted by the principal nations of the world, but he has succeeded in collecting a good deal of useful and accurate information, which he has given in a concise and interesting form.

He deals with the present state of the teaching of physics and chemistry in Germany, Austria, Hungary, Italy, France, Sweden, Norway, Holland, Russia, Finland, Great Britain, Ireland, and the United States of America. In each instance he not only describes the methods of instruction now prevailing, but in a few words indicates the gradual way in which all branches of science are slowly but surely obtaining a recognised place in education.

The chief point dealt with in connection with the teaching of physics and chemistry is the establishment of practical classes for students in the secondary and other schools. In this Great Britain, Ireland, and America are far ahead of the other countries. In Germany, at the present time, comparatively few schools, especially in South Germany, have laboratories where the pupils themselves can carry out experiments in chemistry and physics. Where such practical work has been allowed, it has elicited much interest from the pupils, even when the classes have had

[1] Abhandlungen zur Didaktik und Philosophie der Naturwissenschaft. Heft 3. "Der naturwissenschaftliche Unterricht bei uns und im Auslande." By Dr. Karl T. Fischer. Pp. 72. Price 2 marks. Heft 4. "Wie sind die physikalischen Schülerübungen praktisch zu gestalten?" By Herr Oberlehrer Hahn. Pp. 67. Price 2 marks. (Berlin: Julius Springer, 1905.)

to be held outside the proper school-hours. At the German universities, however, laboratory instruction began relatively early, and now stands on a high level compared with other countries. In Austria, science teaching has been considerably developed, but practical classes have not yet been introduced. In Italy, laboratories for the students at the secondary schools are still unknown, but in France they have been building school laboratories for practical work throughout the country ever since the official regulations of 1902.

In Sweden, the time devoted to natural science is now being increased; scholars can, in most cases, carry out experiments in chemistry, but practical work in physics is almost unknown in the secondary schools belonging to the State. In Norway, there are no secondary school laboratories, although natural science is compulsory. Then again, in Holland, the secondary schools have no practical classes, but the study of physics there is carried further than even in Germany. In Russia, science laboratories are being introduced with considerable success. Until two years ago, physics was the only scientific subject taught in the secondary schools, but since then botany and zoology have been added. The experience gained in Russia in connection with laboratory work has been favourable, in spite of many hampering circumstances. Several recently erected school-buildings have physical departments which have been built regardless of cost; the Physical Institute at St. Petersburg has cost about a million marks, and a still larger one is being built at Moscow.

Dr. Fischer has already shown by his book, "Der naturwissenschaftliche Unterricht in England," that he has an intimate knowledge of English methods of education. His book was the outcome of a visit to this country.

In treating of the teaching of science in the United States of America, reference is made to the alterations in the curriculum of a great number of schools, necessitated by the recent regulation that previous experience in practical physics and chemistry is essential before being admitted to Harvard University and the Lawrence Scientific School.

Finally, various details relating to the universities, technical, medical, and other schools in the countries previously enumerated are given in tabular form; this clearly shows the rapid progress instruction in practical physics has made during the last thirty years. The illustrations include plans and views of laboratories in Munich, Hamburg, Rotterdam, Meppel, Alkmaar, London, &c.

Although space permits of only a very brief reference to some of the principal points dealt with, it is enough to indicate that this pamphlet can hardly fail to interest and to be of use to those who are concerned in the teaching of chemistry and physics.

The pamphlet by Herr H. Hahn, entitled "Wie sind die physikalischen Schülerübungen praktisch zu gestalten?" like that by Dr. Fischer, is one of the separate parts issued, from time to time, by the well known *Zeitschrift für den physikalischen u. chemischen Unterricht.*

Herr Hahn is undoubtedly one of the many teachers of science in Germany who are convinced that the time has now come to introduce the practical teaching of physics into all schools throughout the German Empire. He is endeavouring to attract attention to this subject by describing what has been, and is being, done in other countries, more particularly in England and America. This is probably the best way of refuting the objections of those who oppose this advance.

The first portion is devoted to suggestions as to the best methods of conducting practical physics classes in schools and to the aim of such work. It is pointed out that formerly the object was merely to impart knowledge, but that now it is to show the pupil the way he has to set about to acquire knowledge for himself, to confirm laws which are known to him, and also to discover those of which he is as yet unaware. Much rational advice is given regarding the management of practical classes; special stress is laid upon the advisability of avoiding the use of unnecessarily elaborate and expensive apparatus, and of attempting, when possible, to go back to the simple and ingenious means by which a law was first discovered by one of the great men of science. The author advocates students working singly, and argues that, as all boys, as a rule, work at about the same speed, it is possible to put the whole class at the same experiment; usually one finds, however, it is only the most elementary apparatus that can be stocked on so extensive a scale.

Various other questions are gone into, such as the writing-up of note-books in the laboratory, the supplementing of laboratory work by demonstrations, the training of teachers, &c. From the numerous extracts and foot-notes, one observes that Prof. Hahn has made a most careful and thorough digest of all the existing English and American literature bearing on this branch of science teaching.

The second part deals with laboratories and their fittings, and is illustrated with a number of drawings of fittings, small but clearly executed. These, apparently, are all taken from other books; in fact, about half of them have been reproduced from an English work—Russell's "Planning of Chemical and Physical Laboratories." After some introductory remarks on the size and arrangement of suitable rooms, a description is given of each of the fittings separately, beginning with the simple work-bench for physical laboratories in schools. The ideal is considered to be a bench made to accommodate one worker only, or two in cases of necessity, but it is pointed out that this is too extravagant of floor-space and money to be really practicable. Details of the arrangement, construction, and material of the work-benches are briefly discussed. All the other fittings usually provided are described, and some useful information is given concerning the actual room itself, schemes for heating and ventilating, the supply-pipes, &c.

Again, one notices that a diligent search has been made for English, American, and German books and papers dealing with the fitting-up of laboratories; from these much information and data have been extracted and compared. The search, however, has as usual been most unproductive; one finds in the list of literature merely some five English books and magazine articles, together with two American and three German ones.

Although only a general survey has been attempted of the arrangement and equipment of school laboratories, it would probably be difficult to find a more complete abstract on this subject, and the pamphlet contains much information which will prove useful to those who are fitting-up laboratories.

STANDARDISATION IN PHARMACY.[1]

THE principle of standardisation and its embodiment in daily practice marks the most important advance which pharmacy has witnessed within recent years. Standardisation as applied to a crude drug or a preparation is understood to imply that by a method of appropriate treatment ascertained by direct experiment it has been made to conform to a predetermined standard. The required standard may have a physical, chemical, or physiological basis, and may have reference either to one or more definite principles or to a mixture of indefinable substances. The object of standardisation is to secure uniformity of product, more especially in respect of medicinal activity. It is not necessary to hark back more than a generation to see the ever-lengthening strides which pharmacy has taken in the direction of plant analysis and the isolation of definite principles. To this fact the text-books on materia medica and lectures of twenty-five years ago bear indisputable testimony. Then the maximum of knowledge of the constituents of many of even the best known and most potent drugs was summed up in the statement that they contained a crystalline principle, generally an alkaloid, and a few remotely proximate and chemically unclassified substances. Before standardisation could be brought within the range of pharmaceutical possibility it was necessary to make a more thorough systematic and accurate investigation of crude drugs, with a view of obtaining precise information as to the nature of their constituents.

To this task the younger generation of workers in the field of pharmaceutical research have mainly directed their efforts. Latterly they have occupied themselves more

[1] Abridged from the Presidential Address delivered by Mr. W. A. H. Naylor before the British Pharmaceutical Conference at Brighton on July 25.

especially in seeking to devise trustworthy processes for the assay of crude drugs and their preparations, and to the extent to which they have succeeded they have contributed in their measure to the benefits conferred on suffering humanity by the healing art.

A few pointed observations reflecting my personal opinion on certain aspects of the question of standardisation may not, I trust, be considered inappropriate with which to conclude my address. In my estimation the aim should be to produce preparations that will represent the sum total of therapeutic activity of the drugs operated on except in cases where it is desired to obtain the medicinal effects of certain definite principles the physiological action of which is indisputable. As an illustration a preparation of opium may be cited where the presence of narcotine may be considered objectionable. Further, in respect of a given preparation it must be required of the pharmacist to devise suitable processes not only for the estimation of the chief medicinal constituent, but as far as possible the several medicinal constituents and the proportion in which they are present. I would go even further, and say that in the near future it may be necessary to determine certain principles hitherto disregarded, which modify the therapeutic activity of the drug. The pharmacologist may be depended on to point the way, and despite the heavy tax this call for fuller investigation will put upon the resources of the pharmacist, I am encouraged to believe he will prove equal to the demand. Without reflecting on modern methods of standardisation, which undoubtedly have met with general acceptance, I cannot suppress the conviction that their tendency is not free from a suspicion of narrowness. The besetting temptation consists in a disposition to restrict the medicinal properties of a drug to a potent principle, the therapeutics of which are universally recognised by clinicians, and acting on this assumption to proceed to produce a preparation and to standardise it on the basis of the particular principle and with little or no regard to other constituents that may directly or indirectly be of value. For instance, according to present-day knowledge, the chief active principle of the three drugs belladonna, scopola, and henbane is hyoscyamine. If a tincture of each be prepared so as to contain the same percentage of alkaloid or alkaloidal content, will it be seriously contended that therapeutically considered the three are interchangeable, and therefore it is a matter of indifference which of them is selected for use? If the physician finds it a distinct advantage to administer the belladonna tincture in one case and the henbane tincture in another, surely it is because he is satisfied that the two preparations do not produce identical results. May this not be taken as *primâ facie* evidence that there are in the tinctures constituents present, other than hyoscyamine or alkaloidal content, which claim to be reckoned with?

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The senate has accepted the offer made by the Secretary of State for the Colonies of the sum of 700*l.* a year for five years for the purpose of instituting a chair of protozoology. Of this sum, 200*l.* a year is a contribution from the Rhodes trustees, and 500*l.* a year represents a moiety of a grant originally made from the tropical diseases research fund to the Royal Society for the promotion of research work, and by the Royal Society surrendered for the purpose of endowing the chair. It was decided to devote the whole amount as salary of the professor, and to set aside a further sum of 200*l.* a year to defray the cost of assistants and laboratory expenses in connection with the chair.

Mr. Edgar Schuster, the Francis Galton research Fellow in national eugenics, has presented a report containing a preliminary account of inquiries which have been made into the inheritance of disease, and especially of feeble-mindedness, deaf-mutism, and phthisis.

Of the five commissioners under the Bill promoted by the university and University College for the determination of the conditions under which the college will be incorporated in the university, which measure received the Royal assent on July 11, Lord Justice Cozens-Hardy and Sir Edward Busk were nominated by the university, and Sir John Rotton and Prof. J. Rose Bradford by the college. The remaining commissioner is to be appointed by His Majesty in Council, and will act as chairman. Sir Edward Fry, late Lord Justice of Appeal, has consented to allow his name to be submitted to His Majesty in Council for this post, and it is expected that the Order in Council announcing his appointment will shortly be published.

Under the will of the late Dr. Nathaniel Rogers, a prize of 100*l.* is offered for an essay on "The Physiology and Pathology of the Pancreas." Essays, preferably type-written or printed, must be sent to the secretary of the senate by, at latest, May 1, 1907.

THE services rendered to science by the late Dr. T. M. Drown, president of Lehigh University, are to be fittingly recognised, subscriptions having been invited for the purpose of erecting at the university a building to be called Drown Memorial Hall in his honour.

PROF. W. A. TILDEN, F.R.S., has been appointed dean of the Royal College of Science, South Kensington, in succession to Prof. J. W. Judd, C.B., F.R.S., who retired from the position on July 31.

MR. H. J. HUTCHENS has been appointed demonstrator of bacteriology in the University of Durham. He will continue his work for the Royal Commission on Tuberculosis.

THE subject of the health essay (Durham University) for 1908 is "Injuries and Diseases of the Arteries, Veins and Capillaries, and their Treatment." Essays must be typewritten or printed, and reach the professor of surgery not later than March 31 of the year for which it is to be awarded.

A REPORT on the work of University College, London, for the session 1904–5, was read by Prof. Cormack, dean of the faculty of science, at the assembly of the faculties of arts and laws and of science on July 5. The report records that the Bill for the incorporation of the college in the University of London has passed the House of Lords, and has also passed its first and second readings, as well as the committee stage, in the House of Commons. It is therefore expected that the Bill will receive the Royal assent before the end of the present Parliamentary session. In that case the commissioners, appointed under the Bill to carry out the incorporation of the college in the university, will begin their meetings after the long vacation, and it ought to be possible to complete the actual incorporation by September, 1906. Of the sum of 200,000*l.* required for this purpose, all but 17,000*l.* has been obtained. In the department of applied mathematics the most important event of the session was the generous grant by the Worshipful Company of Drapers of 400*l.* yearly for five years to continue the biometric and research work of the department. This grant has put on a more permanent footing the work already instituted by the same company two years ago. Six memoirs have been specially published as a Drapers' Research Series, and a number of others are in preparation. The work for these has been rendered possible almost entirely by the financial aid provided by this gift. The number of research papers emanating from this department is eighteen, and among them may be noted a paper on "Some Disregarded Points in the Stability of Masonry Dams," which directs attention to a number of complicated and highly important technical questions, and is a valuable contribution both to theory and practice. The research work done in the Pender laboratory during the session has included such practically important matters as :—additional improvements in means for the photometric measurement of the value of incandescent electric lamps; a long research on the magnetic qualities of alloys, not containing iron, which promises to be of great technical importance; and the invention of instruments called cymometers, which are, in effect, electrical spectroscopes, and enable the frequency of the oscillations in any electric circuit to be measured with great accuracy. Several important contributions to science have come from the department of chemistry; and the list of publications by investigators in this and other departments shows that the activity of the college in producing original work is being maintained.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 24.—M. Troost in the chair.—On the total eclipse of August 30: M. **Janssen.** Observations will be taken at Alcocebre, near Valencia, in Spain.—On a simple case from which can be easily calculated the mutual action of consecutive rings constituting a tube, and on the influence of this mutual action on the propagation of liquid waves in this tube: J. **Boussinesq.**—On the nature of the hydrocyanic glucoside of the black elder: L. **Guignard** and J. **Houdas.** The bruised leaves were macerated with water for twenty-four hours at a temperature of 25° C.; the liquid gave a distillate from which semicarbazide separated a crystalline precipitate, identical with benzaldehyde semicarbazide. This result, together with the formation of hydrocyanic acid, shows that the elder leaf contains amygdalin.—The catalytic decomposition of monochlor-derivatives of methane hydrocarbons in contact with anhydrous metallic chlorides: Paul **Sabatier** and A. **Mailhe.** The chlorides of nickel, cobalt, iron, cadmium, lead, and barium, at a temperature of about 300° C., readily decompose the fatty alkyl chlorides, giving hydrochloric acid and the corresponding ethylene. The reaction does not take place with methyl chloride, but ethyl, propyl, isobutyl, and isoamyl chlorides readily decompose under these conditions, barium chloride being the most convenient catalytic agent.—The convergence of rational fractions: H. **Padé.**—Experimental researches on the effect of membranes in liquid chains: M. **Chanoz.** The effect of the membrane on the observed electromotive force may be provisionally explained by the formation at the expense of the electrolyte of a double electric layer in contact with the membrane.—The hysteresis of magnetisation of pyrrhotine: Pierre **Weiss.**—On a dihedral stereoscope of large field, with bisecting mirror: Léon **Pigeon.**—On fluorescence: C. **Camichel.** An experimental proof that the coefficient of absorption of a fluorescent body does not vary at the moment of fluorescence, and that the intensity of the light emitted by the fluorescence is proportional to the intensity of the exciting light.—The influence of water vapour on the reduction of carbon dioxide by carbon: O. **Boudouard.** The reduction of carbon dioxide by carbon at temperatures between 650° C. and 1000° C. is practically unaffected by the presence of water vapour, the state of equilibrium being nearly identical whether the gases are dry or moist.—On an extension to oxide of zinc of a method of reproduction of silicates of potassium and other bases: A. **Duboin.**—On a sub-iodide of phosphorus and the part played by this body in the allotropic transformation of phosphorus: R. **Boulouch.** The sub-iodide is produced by the action of sunlight on a solution of iodine and phosphorus in carbon disulphide; it is formed as a precipitate, being insoluble in carbon disulphide, and has the composition P_4I. It is decomposed by dilute potash solution, losing its iodine and apparently forming P_4OH.—On a potassium iridiochloronitrite: L. **Quennessen.**—The action of sodium sulphite upon ethanal: MM. **Seyewetz** and **Bardin.** Under certain conditions, details of which are given, crotonic aldehyde is formed in this reaction, the yield (40 per cent.) being sufficiently good to make this a preparative method.—On sparteine: the hydrates of methyl-, dimethyl-, and trimethylsparteine: Charles **Moureu** and Amand **Valeur.**—On gentiine: Georges **Tanret.** Gentiine is the glucoside accompanying gentiopicrin. Hydrolysed with dilute sulphuric acid, gentienine, glucose, and xylose are formed. It is noteworthy that this is the first known glucoside which gives xylose amongst its products of hydrolysis.—The chemical equilibrium of the system: ammonia gas, isoamylamine chlorhydrate: Félix **Bidet.** Pressures are given both for the direct and inverse reaction at −23°, −9°, −5°, 0°, and 16°, the concordance between the two sets of observations being quite satisfactory.—On the regeneration of the bruised radicle: P. **Ledoux.** There is no regeneration of the parts cut, and in the case of the lateral roots there are other anatomical differences.—On the shrimps of the genus Caricyphus arising from the collections of the Prince of Monaco: H. **Coutière.**—On the growth in weight of the chicken: Mlle. M. **Stefanowska.** Curves of growth are given for both sexes; there is a point of inflection in the curves for the male when it has attained 77 per cent. of its maximum value, and for the female at 21 per cent. The results of the observations are expressed empirically in two hyperbolas.—Experiments on the mechanical washing of the blood: Ch. **Répin.**—Intra-organic combustions measured by the respiratory exchanges as affected by residence at an altitude of 4350 metres: G. **Kuss.** These observations were carried out on several subjects at the summit of Mt. Blanc. There were seven persons under experiment; they stayed at the observatory on the summit from four to ten days, their respiratory coefficients being determined several times daily. Both before and after their stay on Mt. Blanc observations were made at Chamonix (1065 metres) and at Angicourt (100 metres). The conclusions drawn from the whole of the experiments are that the respiratory exchanges are not sensibly modified by a prolonged stay at great altitudes, and a slight attack of mountain sickness is also without influence on the results.—On the presence of poison in the eggs of bees: C. **Phisalix.** The eggs of bees contain a small amount of poison of the same nature as that present in the adult bee. Each egg contains about 0·001 mgr. of the venom, and as each egg weighs about 0·15 mgr. it follows that the toxic substances present amount to about 1/150th part of its weight.—On the production of mechanical work by the adductor muscles of the Acephalæ: F. **Marceau.**—On the structure of the muscles of the mantle of cephalopods with respect to their mode of contraction: F. **Marceau.**—The germination and growth of the artificial cell: Stéphane **Leduc.**—The study of the diaphragm by means of orthodiascopy: H. **Guilleminot.**—The general movements of the atmosphere in winter: Paul **Garrigou-Lagrange.**

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THURSDAY, AUGUST 10, 1905.

SOCIOLOGICAL SPECULATIONS.

A Modern Utopia. By H. G. Wells. Pp. xi+393. (London: Chapman and Hall, Ltd., 1905.) Price 7*s.* 6*d.*

IT is instructive to watch the growth, both in power and in hopefulness, of Mr. Wells's criticism of life. In the "Time Machine" his forecast of the future of humanity was frankly appalling; in "When the Sleeper Wakes," more lurid (albeit far more probable) than the worst imaginings of "reforming" socialists. "Anticipations" was a most stimulating book, but so deliberately confined itself to exalting and exaggerating the prospects of a single aspect of life, so exclusively devoted itself to glorifying mechanical and material progress, that those sensitive to our spiritual and æsthetic possibilities might be pardoned for regarding the present order, with all its cruelty, waste, sordidness, and grotesqueness, as a golden age in comparison with Mr. Wells's world. "Mankind in the Making" contained much vigorous criticism and many sensible and practical suggestions. In the present book Mr. Wells has become still more moderate and practicable and hopeful, without in the least derogating from his ingenuity and originality. We sincerely hope, therefore, he will not, as he threatens, stick henceforth to his "art or trade of imaginative writing," but will continue from time to time to regale and stimulate us with sociological speculations.

Stripping off the romantic form—in which Mr. Wells dreams himself and a companion, a botanist suffering from a chronic affair of the heart, into a distant planet which is an exact duplicate of our earth, save that it has realised all the good which is attainable with our present resources—his main argument may be condensed as follows.

As the philosophic foundation of his whole enterprise, Mr. Wells assumes what he calls the "metaphysical heresy" (though it is rapidly forcing itself upon the notice even of the most stagnantly "orthodox" philosophers) that all classifications, though convenient, are crude, and that whatever is real and valuable in the world is individual, a thesis he had expounded in the brilliant contribution to *Mind* entitled the "Scepticism of the Instrument," which he has now reprinted as an appendix to his book. From this philosophy he infers that progress depends on individual initiative and variation, leading to successful experiment. Hence the infinite preciousness of freedom, which the Utopian World-State must restrict only when and in so far as it would oppress the freedom of others. Hence, too, there will be extensive toleration of "cranks," while even criminals would merely be segregated as failures and condemned to work out their ideas of a good life in a society of their likes, after a fashion charmingly described in the account of the arrival of involuntary immigrants at the "Island of Incorrigible Cheats." But though Utopia is strangely kind to the cranky, the criminal and the inefficient, because it regards their occurrence as the measure of the State's failure, it does not allow them to reproduce their kind. Parentage is a privilege, and the production of superior offspring a service to the community for which a wise State will handsomely reward its women.

But the efficiency and prosperity of the Utopian order ultimately depend on the ruling class, which Mr. Wells seems to have taken bodily out of the Platonic Republic, and, with a fine compliment to the unparalleled rise of Japan, entitled the "Samurai." The Samurai are conceived as a "voluntary nobility" which (like the mediæval Church) all may enter who are able and willing to lead the strenuous and somewhat ascetic life prescribed by the rules of the Order. Among these the obligations to buy and read every month at least one book published in the last five years, and every year to go out into the wilderness and to travel through it in silence and solitude for at least seven days, are perhaps the most noticeable, together with the prohibition of acting, singing and reciting, and the playing of games in public.

It is remarkable how Platonic is the general spirit of these institutions in all save the high appreciation of individual freedom, to the value of which Plato showed such singular blindness. Nor is their general aim hard to discover. At several points, however, a critic will be disposed to doubt whether Mr. Wells's means are adequate to his ends. He has seen, indeed, what never seems to have occurred to Plato, that if wisdom is to control the State, elaborate precautions must be taken to keep learning progressive, and to prevent it from fossilising into pedantry. The Platonic State, if it could ever have come into existence, would systematically have suppressed originality, and simply have stereotyped the condition of science and art prevailing at the date of its institution. If it could be conceived as surviving to the present day, it would still be sending its heroic hoplites against quick-firing guns, and still be punishing a belief in evolution or metageometry as heresies worthy of death. Mr. Wells seeks to guard against the universal human tendency to fix in rigid forms whatever man admires. But though he insists on the importance of preserving the "poietic," *i.e.* originative, types of man and endowing their researches, it may be doubted whether even under his laws they would not be overpowered by the "kinetic," *i.e.* the efficient administrators, who everywhere conserve the established order. For these latter would control the Order of the Samurai.

Again, Mr. Wells's distrust of eugenics, justified as no doubt it is by the present state of our knowledge, seems unduly to disparage the prospects of scientific discovery in the future. It does not follow that because now we know too little to entrust the State with the function of controlling the reproduction of the race, this will continue to be unsafe, and it is easy to imagine circumstances in which such control would become almost inevitable. For example, if one of the many attempts to discover what determines the sex of an embryo should chance to be crowned with success, the numerical equality of the

sexes would in all probability be gravely imperilled, and the State would almost certainly have to intervene. Again, while Mr. Wells is doubtless within his rights in scoffing at the racial prejudices of the time, in his scorn of popular notions of "superior" races, "including such types as the Sussex farm labourer, the Bowery tough, the London hooligan, and the Paris apache," and in his contention that "no race is so superior as to be trusted with human charges," his anticipation of wholesale racial fusions seems to involve a serious underestimate of the æsthetic instincts. Lastly, although Mr. Wells has keenly perceived the spiritual value of a temporary retreat from society, it may be doubted whether he does not purchase its advantages at too high a cost. The solitary voyages of his Samurai would assuredly lead to a high death-rate among them, and though one type of mind was thereby strengthened, another would be unhinged. The rule, in short, seems too rigid for the variety, and too cramping for the freedom, of man, both of which Mr. Wells is elsewhere anxious to appreciate. But Mr. Wells, on the whole, shows a wisdom far superior to that of former Utopists in not seeking to construct out of the imperfect materials which alone the actual can furnish a static order which shall be, and if possible remain eternally, perfect. He aims rather at laying down the principles of an order which shall be capable of progressively growing towards perfection; and so it may well be that in his ideal society men will be less reluctant than now to learn from experience.

F. C. S. S.

THERMODYNAMICS.

Thermodynamik. By Dr. W. Voigt. Vol. ii. Pp. xii+370. (Sammulung Schubert, xlviii.) (Leipzig: G. J. Göschen, 1904.)

Diagrammes et Surfaces thermodynamiques. By J. W. Gibbs. Translated by G. Ray, of Dijon, with an introduction by B. Brunhes, of Clermont. Pp. 86. (Paris: Gauthier-Villars, 1903.)

THE second volume of "Thermodynamik" deals essentially with applications. It is divided into two parts, devoted to thermochemical changes and thermoelectric changes respectively. Under the first heading are included changes of phase of a single substance, which occupy the first 168 pages. In this connection we have sections dealing with Van der Waals's formula, steam and gas engines, the equilibrium of an atmosphere of water vapour, and the Hertzian adiabatics. The next chapter deals with phases formed of more than one component, the properties of binary mixtures occupying about 80 pages, and those of a system with more than two components being treated subsequently. The part dealing with thermoelectric changes contains a good bit of introductory matter on electrostatics. In the third chapter of this part the properties of black-body radiation are discussed at much length.

The subject of thermodynamics can be defined in various ways. In its most restricted sense it deals exclusively with the first and second laws and direct deductions from them, in just the same way that dynamics deals with direct deductions from the laws of motion. But the name thermodynamics is often used to include all phenomena directly or indirectly associated with heat, and it is in a fairly broad sense in this respect that Dr. Voigt deals with the subject. A good many of the formulæ are based more or less on experiment or reasoning not directly connected with the two laws of thermodynamics. Thus, for example, in the chapter on radiation the only piece of work which can be regarded as thermodynamical in the narrower interpretation is the proof of the equation by which Stefan's law is deduced from the formulæ for radiation pressure. But in addition to this we have here a general discussion of radiation based on electrodynamical considerations, Wien's law, Planck's law of mixture, and Kirchhoff's theorem. The relation between the black radiation and wave-length is in no way deducible directly from the first and second laws.

These examples may be taken as affording some indication of the extended scope of the book. Passing to matters of detail, the author is to be congratulated on the lucid way in which he clears up many points usually regarded as obscure. We may instance the detailed discussion of the thermodynamical potential of a gas-mixture (§ 69), a point which receives scanty attention in many books we have seen. The author's task is made easier by the fact that most of the higher applications of thermodynamics deal with *equilibrium*. Now, whether we deduce the conditions of equilibrium from making the available energy a minimum, the entropy a maximum, or by any other equivalent hypothesis, the variation of the function selected must in general vanish to the first order, so that the conditions of thermodynamic equilibrium (apart from stability) are deducible from the equations of *reversible* thermodynamics. Very little is said in this book about irreversible phenomena, and this is perhaps fortunate owing to the great difficulty of dealing with these phenomena in a clear and logical way. The kind of impression which a beginner is likely to form in reading about irreversible thermodynamics may be exemplified by the following three apparently contradictory statements:—"The increase of entropy is dQ/T." "The entropy of the universe tends to a maximum." "For a cyclic irreversible cycle $\int dQ/T<0$."

It would be hardly an exaggeration to assert that whether any statement in irreversible thermodynamics is right or wrong depends entirely on the way of looking at it. For example, in § 105 a very little is said about irreversible electric phenomena, which is doubtless correct according to the author's interpretation; but whether this is the best way of stating the case is necessarily a matter of opinion.

In connection with the continuity of the liquid and gaseous states, the rule for the horizontal line in the isothermal diagram is deduced from van der Waals's equation (p. 151), and is not treated as a general result. In this method, however, the significance of the rule is somewhat lost. The proper condition that the rule may hold good is that the liquid and gaseous

states should be connected up in the (p,v) plane by a system of curves $T=$constant, consistent with the differential equation

$$\frac{dy_v}{dv} = T\frac{d^2p}{dT^2},$$

and making y_v equal to the specific heat at constant volume in the regions which represent physically possible states. For the validity of the rule it does not matter how the curves are joined up provided that the above differential equation is everywhere satisfied.

The notation may appear somewhat cumbersome, but anyone who tries to express thermodynamical formulæ in writing will find it impossible to do so clearly and precisely without some such large array of symbols. In particular, the use of capital letters for the volume, entropy, energy, and other thermodynamic magnitudes of a whole body, and small letters for the corresponding magnitudes per unit mass, is a very useful convention. The different forms of d, δ used for differentiations, variations, and diminutions are less easy to follow. If we attempt to compare the subject of this volume with Prof. Planck's excellent little treatise, we shall probably come to the conclusion that Prof. Voigt goes more into elaborate details, while Prof. Planck keeps more to the main points. The book now before us thus contains the more information about a wide range of physical phenomena, but Prof. Planck's book is the easier to read. Neither book can be said to be better or worse than the other, as each has its own uses.

The French translation, which forms No. 22 of the physico-mathematical series appearing under the title of *Scientia,* contains the two papers "Graphic Methods in the Thermodynamics of Fluids" and "A Method of Geometric Representation of the Thermodynamic Properties of Substances by Means of Surfaces," both originally published in the Connecticut Transactions for 1873. It is accompanied by a short notice of Gibbs's life and works, and an introduction by Prof. Brunhes. The latter, giving as it does a general and explanatory account of the subject-matter of the papers translated, forms a useful addition to the book.

G. H. B.

FUNGUS-GALLS.

Beiträge zur physiologischen Anatomie der Pilzgallen. By Hermann Ritter von Guttenberg. Pp. 70; with 4 plates. (Leipzig: Wilhelm Engelmann, 1905.) Price 2s. 9d. net.

THE study of galls is never more profitably approached than when the mutual inter-reactions between parasite and host-plant are considered conjointly. The intimate connection existing between these two, whether the parasite be insect or fungus, forbids the divorce of either party, and it is therefore a pleasure to come across a work in which this close union is recognised, and an endeavour made to explain the anatomical changes occurring in fungus-galls from a physiological standpoint.

In this work the effects caused by five different fungi on as many host-plants are described. The fungi all belong to separate families, as also do the hosts, and the series is therefore admirably suited for generalising the results. It includes Albugo on Capsella, Exoascus on Alnus, Ustilago on Maize, Puccinia on Adoxa (where, however, no gall-formation arises), and Exobasidium on Rhododendron.

The constancy of form and complexity of structure, characteristic of many insect-galls, are not found here, and the principal changes observable may be briefly summarised as consisting of the hypertrophied development of a large-celled, thin-walled parenchymatous tissue containing very vacuolated protoplasm, enlarged nuclei, and rich stores of starch or water. This is accompanied by an increase in the number of vascular bundles, or at least of their elements, and by modifications of the epidermis, whilst the assimilatory and aërating systems generally tend to be suppressed.

These anatomical changes are, in the author's opinion, mostly due to a change of function which the tissues assume under the influence and for the exclusive benefit of the parasite. The fungus may almost be regarded as a sculptor working with clay. It moulds the host-plant at will, forcing it to lay down a store house and fill it with food for the tenant's use, forcing the xylem to predominate when water is needed, or the phloëm when carbohydrates are required. Where spore formation is proceeding, accessory bundles are laid down to provide the increased supplies necessary. Here the epidermis is weakened so as not to hinder the dispersal of spores, there the mechanical tissue suppressed lest the progress of the fungus be impeded, while even the chlorophyll granules, when present, work in the service of the parasite. Everywhere the story reads as if the host had become wholly subservient to the will of the parasite; but were the author now to exchange his brief and act as counsel for the host, he might equally well explain many of the changes as evidencing an intense effort put forth by the latter to overcome the former. A final summing up would then be less partial, and productive of still more valuable results.

Here and there the author *has* observed indications of this struggle, and one point to which he directs attention is of special interest, viz. the deposit of a cellulose cap or sheath around the invading haustorium or hypha, apparently for the purpose of preventing its entry. This phenomenon, which, though of frequent occurrence, is not generally known, is most remarkable in *Ustilago Maydis,* where the whole length of an intracellular hypha in its passage through a cell may become enclosed in a cellulose tube. Subsequently this tube may become irregularly thickened in parts, and then shows distinct stratification.

The observations regarding the behaviour of the nucleus—its lobed appearance, occasionally leading on to amitotic division, its participation in the formation of the above mentioned cellulose sheath, its subsequent decrease in size, the aggregation of the chromatin at the periphery, &c.—are all most interesting. Some of them need confirmation by more exact histological methods than the author seems to have employed, before his conclusions can be accepted, *e.g.*

the fate of the nucleus in the epidermal cells of *Alnus incana*, which appears very doubtful. In a few other points doubts have also arisen in the writer's mind whether certain appearances described may not have been due to imperfect fixation.

The discussion concerning the attraction which the nucleus apparently exerts on the haustoria is reverted to in the section dealing with *Puccinia Adoxae*, and the solution arrived at seems natural and satisfactory.

Space will not permit us to mention many other points of interest which the reader will find in this little book. A perusal thereof will, it is believed, repay the mycologist, who, even if he doubts a few of the facts or considers the conclusions often somewhat forced, will at all events find the subject treated from a new point of view, and will thereby gain a stimulus for his own researches.

E. R. BURDON.

OUR BOOK SHELF.

Report on the Injurious Insects and other Animals observed in the Midland Counties during 1904. By Walter E. Collinge, M.Sc. Pp. v+64. (Birmingham: Cornish Bros., 1905.)

THIS is the author's second report. It deals with injurious insects and other animals which have been forwarded to him by various correspondents in the midland counties during 1904.

The work is not bulky, but contains in its sixty-nine pages a great amount of valuable matter, covering a wide ground. Its value is enhanced by twenty-nine illustrations; many of these are those used in the Board of Agriculture leaflets, and some could certainly be improved on, such as Fig. 17, the winter moth, and Fig. 22, the codling moth. The original illustrations are excellent, including those of the goat moth, the birch gall mite, crane flies, and yellow underwing larvæ. Among the most interesting notes are those on a supposed new apple mite (Eriophyes, sp.) and on carnivorous slugs.

With regard to the latter, the author tells us that living specimens have been introduced into greenhouses and nursery gardens with very beneficial results. This kind of work is most valuable, and we hope Mr. Collinge will have a larger supply to dispose of among nurserymen in future.

There is a detailed and able account of the pear midge (pp. 42–49), but amongst the supposed remedial measures we find it recommended "to deeply trench the ground beneath the trees." This has probably crept in by error. The goat moth is treated in a short, concise manner, and this paper is excellently illustrated with photographs.

Amongst other fruit pests that the author has had reported from the midlands may be mentioned the apple blossom weevil, codling moth, the plum bark beetle, winter moth, the currant clearwing, magpie moth, and, needless to say, one of the most serious pests in Herefordshire, the apple sucker. A few short notes are also given on parasitic diseases of animals, such as scaly leg in fowls, gapes in poultry, and the pig louse.

In the appendix the use and employment of hydrocyanic acid gas and bisulphide of carbon are dealt with, and a general account of insects and the classification briefly referred to. The author divides the Hexapoda into fourteen orders.

As this report should fall into the hands of practical men, we regret to see new generic names are given in the text. Scientific names have rather a frightening effect, and when we keep changing them it makes matters worse. Probably it would be better if we kept to popular names only in the text of such reports, and referred the reader to the scientific names in an appendix. The farmer and gardener want these matters put before them in as simple a way as possible.

We look forward to another of these reports with pleasure, and hope they will appear annually for the benefit of grower and economic zoologist alike, for the contents of the pages of the one before us are both scientifically accurate and preeminently practical.

F. V. T.

Studies of the Museums and Kindred Institutions of New York City, Albany, Buffalo, and Chicago, with Notes on some European Institutions. By A. B. Meyer. *Rep. U.S. Nat. Mus.* for 1903. Pp. 311–608; plates. (Washington, 1905.)

DR. MEYER'S valuable notes and comments on the museums of America and Europe are already familiar to our readers by the notices published in our columns of the issues of the original German text. Of that text the present volume is a translation, revised by the author himself, and with all the original illustrations reproduced, although in some instances on a smaller scale. Since the author's tour of inspection was primarily undertaken for the purpose of learning all that was to be learnt from American museums, the consideration of which occupies by far the greater portion of the report, it was only right and proper that an English translation of the latter should be issued in America rather than in this country, and the Smithsonian Institution deserves the thanks of all interested in museums for the excellent manner in which it has carried out its self-imposed task.

The translation will indeed be fully as acceptable in England as it can be in America, for Dr. Meyer is an outspoken critic who does not mince his opinions, and some of his views with regard to the organisation, installation, and conservancy of museums in this country cannot fail, from this same outspoken and candid manner, to have a permanent value.

Especially important are his opinions with regard to the deteriorating effect of light on the collections of recent zoology in the Natural History Museum in Cromwell Road.

"Everywhere in England," he writes, "the collections are exhibited during the entire day, and it is said that this custom must continue, otherwise the money for expenses will not be forthcoming. I think, however, that this is an error. If the officials themselves were only convinced that the collections intrusted to their keeping are really being injured, they would be able to impress this fact upon the trustees. . . . The public would soon become accustomed to shorter hours of opening if there were some way of making them generally known." Would they?

Whether or no we accept all the author's views and criticisms, there can be no doubt that the issue of an edition of Dr. Meyer's "museum survey" in English is a matter for all-round satisfaction. R. L.

Notes on Assaying and Metallurgical Laboratory Experiments. By Prof. Richard W. Lodge. Pp. viii+287. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 12s. 6d. net.

PROF. LODGE has brought together in this book the notes which have been in use for many years by the third-year students in assaying at the Massachusetts Institute of Technology and part of the notes given to fourth-year students. The book may therefore be

taken as representing the teaching given to metallurgical students in America, and forms an interesting study to those who wish to know something of the much-praised methods in vogue there. Judging from the contents of Prof. Lodge's volume, the methods do not differ much from those in use in this country and in other parts of the world. The assaying of gold and silver ores is dealt with adequately, and there is an interesting though incomplete chapter on the metals of the platinum group, but the rest of the third-year work (the assay of bullion and of copper and tin ores) is scrappy and of little value. The notes for the fourth-year's work would also not be of much help to students. For example, in the section on cleaning mercury, the student is recommended to wash away soluble and light material with a stream of water, and then to "decant off water and add a small piece of potassium cyanide (poison), which ought to clean it nicely." The author seems to have some misgivings as to whether base metals would really be removed in this way, but the true nature of the problem is nowhere stated, nor are the correct methods of purification described.

In the more valuable part of the book, the assaying of gold and silver ores is discussed at considerable length. The following differences between the instructions given to the student and those usually given in England are noteworthy:—(1) In scorification the slags are not cleaned by the addition of carbon after the eye of lead is closed. (2) In cupellation, the formation of feathers of litharge is strongly insisted on. (3) Beads from gold ores are parted by boiling three times in nitric acid of different strengths.

A large number of exact experiments in assaying are described, and inferences drawn from them. Such work is always useful, but it is better not to put it before students until it has been discussed. Some of the inferences given can hardly be accepted, such, for example, as that the presence of silver does not diminish and that of copper does not increase the cupellation loss of gold. A word of protest may be uttered against the low standard of draughtsmanship in the illustrations. The scorifying tongs, depicted twice, on pp. 13 and 38, are absolutely startling.

T. K. R.

The Practical Photographer. Library Series. Edited by Rev. F. C. Lambert. No. 18, *Gum-bichromate Printing.* Pp. xxiv+64. No. 19, *Floral Photography.* Pp. xx+64. No. 20, *Portraiture.* Pp. xxviii+64. No. 21, *Orthochromatic Photography.* Pp. xx+64. No. 22, *Figure Studies, Groups and Genre.* Pp. xx+64. No. 23, *Summer Number.* Pp. 64. (London: Hodder and Stoughton, 1905.) Price 1s. net each.

THE reputation of this excellent series of photographic books is well maintained in the above-named additions to this useful library. As in previous issues, each volume is the work of numerous authors, and the value of the series is that the information is given by those who are at work at the various subjects, and therefore more practical than theoretical.

The illustrations, which are very numerous in each number, are all of a high order of efficiency, and add greatly to the value and utility of the text. The editor in each case contributes an interesting article on the pictorial work of some photographer of note, and those included in these numbers are, in the order of the books given above:—Charles Moss, Mrs. Cadby, Furley Lewis, Harold Baker, William Rawlings, and F. J. Mortimer. An important feature of each of these essays is the reproduction of specimens of their work. As practical handbooks these new volumes will be found very serviceable.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Exploration of the Indian Ocean.

MR. STANLEY GARDINER, leader of the Sladen Trust Expedition for the exploration of the Indian Ocean between Ceylon and the Seychelles, in H.M.S. *Sealark*, has sent me the following short account of the progress of the expedition up to the date of writing. The letter is written from the Salomon Atoll, Chagos Group, and is dated June 4.

A. SEDGWICK.

Trinity College, Cambridge, August 4.

"We came on board H.M.S. *Sealark* on May 8 at Colombo. Weighing anchor the following evening we set a course for Peros Banhos, the large N.W. atoll of this group, but on the second day out appreciated the fact that we were getting in for the commencement of the burst of the S.W. monsoon. On May 14 we had reached a latitude south of the Maldives, and commenced sounding in view of the possible existence of a bank between this group and the Chagos as indicated by the soundings taken by the German *Valdivia* Expedition. I may say at once that our soundings showed a depth of more than 2000 fathoms between the two groups. The depth increases from the Maldives and Chagos towards the centre of the passage between, but in this position there would seem to be a broad flat, extending along the line of latitude with a depth of 2000 to 2150 fathoms. Of course both east and west the depth probably increases gradually to 25,000 fathoms or even more, but one obviously cannot build up any views of a possible former connection of the Maldive and Chagos Banks on such a slender basis.

"On our way down we took samples of the sea-water and of the plankton (pelagic fauna) at the surface and at every 25 fathoms to 150 fathoms, using a wire with a heavy weight at the end running over a measuring block and clamping on the nets as each 25 fathoms ran out. We also took a series of hauls with the Fowler and Wolfenden closing nets, so as to get our wire into trim, &c. The weather was dead calm with a moderate swell, and generally our results were satisfactory. The Fowler net, being opened at a certain depth and then hauled up vertically to a lesser depth and closed, seemed more suitable for the conditions prevailing in this region than the Wolfenden, which is opened and closed at the same depth, being dependent on the drift of the ship, in the absence of any deep-sea current, for what enters the actual net; heavy messengers, too, are essential for opening and closing the nets. Of course these results on the depth of pelagic animals have a value of their own, but our best haul from a collector's point of view was that of a large net, mouth one yard square, length about twelve yards, made of strong mosquito cloth, ten meshes to the inch. This net we let down on 1200 fathoms of wire and hauled in as fast as our winch could take it. Unfortunately the wire became tied up most abominably, but the comparison of the contents of the tin with the collections made by the Fowler net showed that the net itself must have actually sunk to 600 or 700 fathoms. The presence in the tin of a series of prawns (one 6 inches long), a cuttle fish, and many strong swimming jelly-fish suggests that the use of this method of investigating the swimming fauna (nekton) of the sea should yield valuable results.

"On May 19 we anchored at Île de Diamant, Peros Banhos Atoll, but it became obvious in the next couple of days that in the S.E. trade winds now prevailing in this region, any thorough examination of this atoll, open as it is to the S.E., would be impossible. Accordingly we moved on to the Salomon Atoll on May 22, coming on shore to camp on the following day, selecting it as being of small size (5 miles long by 3½ broad) and enclosed on all sides, save for one passage to the north, by a surface reef. While Cooper and I are collecting the marine fauna and flora, and examining the reefs and land, Captain Somerville and the officers of H.M.S. *Sealark* are making a fresh chart of the atoll on a large scale,

while Mr. Fletcher, paymaster, and Dr. Simpson are collecting the insects and land plants. I may say at once that the latter are of the type which one would expect to find on purely oceanic islands, but their distribution from island to island is interesting, as well as their preferences for sand or rock, drought or moisture, &c., most of the islands having definite zones with their peculiar plants.

"It is really as yet too early to say anything about the reefs here, as there are one or two places which I have not yet been able to visit. What strikes one, however, very forcibly is the comparative absence of life on them. Of course there are in places plenty of corals, but the number of species is quite limited. There is a fair number of the usual Alcyonaria, but Sponges, Hydroids, and Tunicates are very few in species and in quantity. Turbellaria are very rare, while Molluscs, Echinoderms, and Crustacea are few in species and, except certain common forms, not numerous. Ptychodera we have obtained, as well as a few Sipunculids, but Amphioxus and Thalassema we have not found. At Minikoi in two tides I have brought to the camp as great a variety of animals as Cooper and I have obtained here working ten tides up to the present. Indeed, life here is strictly limited in variety, and, when the marine collections have been fully worked up, one is inclined to anticipate, even so early, that some definite light will be thrown on the distance to which the larvæ of marine animals can cross the open ocean, on the distribution, in fact, of marine animals. The same, too, is true as well of the marine plants, nullipores alone being common.

"I am now endeavouring to work up the physical conditions of the atoll so as to find, if possible, whether there is any physical cause for the comparative paucity of free-living animals. I am sending Cooper in the ship tomorrow to Diego Garcia, where he will have four or five days while she is coaling to examine the land and reefs. I remain here, but I hope by the time of his return, in about twelve days, to have finished my work and to move on to Peros Banhos, while the *Sealark* is sounding between the banks and round the Chagos Archipelago."

The Problem of the Random Walk.

I HAVE to thank several correspondents for assistance in this matter. Mr. G. J. Bennett finds that my case of $n=3$ can really be solved by elliptic integrals, and, of course, Lord Rayleigh's solution for n very large is most valuable, and may very probably suffice for the purposes I have immediately in view. I ought to have known it, but my reading of late years has drifted into other channels, and one does not expect to find the first stage in a biometric problem provided in a memoir on sound. From the purely mathematical standpoint, it would still be very interesting to have a solution for n comparatively small. The sections through the axis of Lord Rayleigh's frequency surface for n large are simply the "cocked hat" or normal curve of errors type; for $n=2$ or 3 they do not resemble this form at all. For $n=2$, for example, the sections are of the form of a double U, thus UU, the whole being symmetrical about the centre vertical corresponding to $r=0$, but each U itself being asymmetrical. The system has three vertical asymptotes. It would be interesting to see how the multiplicity of types for n small passes over into the normal curve of errors when n is made large.

The lesson of Lord Rayleigh's solution is that in open country the most probable place to find a drunken man who is at all capable of keeping on his feet is somewhere near his starting point! KARL PEARSON.

Proposed Magnetic and Allied Observations during the Total Solar Eclipse on August 30.

IN response to my appeal for simultaneous magnetic and allied observations during the coming total solar eclipse, cooperative work will be conducted at stations distributed practically along the entire belt of totality and also at outside stations, nearly every civilised nation participating.

These observations will afford a splendid opportunity for further testing the results already obtained. All those who are able to cooperate are invited to participate in this important work.

The scheme of work proposed embraces the following:—

(1) Simultaneous magnetic observations of any or all of the elements according to instruments at the observer's disposal, every minute from August 29, 22h., to August 30, 4h., Greenwich mean astronomical time.

[To ensure the highest degree of accuracy attainable, the observer should begin work early enough to have everything in complete readiness in proper time. See precautions taken in previous eclipse work as explained in the journal *Terrestrial Magnetism* (vol. v., p. 146, and vol. vii., p. 16). It is essential, as shown by past experience, that the same observer make the readings throughout the entire interval.]

(2) At magnetic observatories, all necessary precautions should be taken so that the self-recording instruments will be in good operation, not only during the proposed interval, but also for some time before and after, and eye readings should be taken in addition wherever it be convenient.

[It is recommended that, in general, the magnetographs be run on the usual speed throughout the interval, and that, if a change in the recording speed be made, every precaution possible be taken to guard against instrumental changes likely to affect the continuity of the base lines.]

(3) Atmospheric electricity observations should be made to the extent possible by the observer's equipment and personnel at his disposal.

(4) Meteorological observations in accordance with the observer's equipment should be made at convenient periods (as short as possible) throughout the interval. It is suggested that, at least, temperatures be read every fifth minute (directly after the magnetic reading for that minute).

(5) Observers in the belt of totality are requested to take the magnetic reading every fifteen seconds during the time of totality, and to read temperatures as frequently as possible.

(6) At those stations where the normal diurnal variation cannot be obtained from self-recording instruments, it is desirable to make the necessary observations for this purpose on as many days as possible before and after the day of the eclipse, and to extend the interval of observations given above if conditions permit. In general, those who will have self-recording instruments have decided to run them for at least eight days before and after the day of the eclipse.

It is hoped that observers will send full reports of their work to me as soon as possible for incorporation in the complete monograph on this subject to be published by the Carnegie Institution of Washington.

L. A. BAUER.

Department Terrestrial Magnetism, Carnegie Institution, Washington, D.C., July 15.

British Fruit Growing.

IN your remarks on p. 297 (July 27) on the above subject, you mention "the diversity of yield from farms in the same neighbourhood . . . due presumably to differences of shelter and aspect." It is a remarkable thing that, so far as I know, nothing has ever been done to find out and publish the most suitable localities, as regards soil and climate, for orchard planting. It is a question of very great complexity, and can only be dealt with properly by officials appointed for that purpose; but its importance in fruit culture is so obvious that a considerable expenditure would be well repaid. Few people have any idea of the great climatic differences in localities within even a few hundreds of yards!

This house is on the south slope of the long range of Lower Greensand hills which runs parallel with the Chalk range the whole length of Kent from west to east. At this point the slope rises steeply from 200 feet above sea-level to 500 feet, my house being about 350 feet. I have carefully observed the effects of frost, &c., for the last six years, and it appears to me that the variations in temperature in the vertical limits mentioned are much greater than would be expected. Up to the 400-feet contour line the climate is singularly equable, which is proved not only by daily thermometrical observations, but by the

fact that such tender plants as *Cistus purpureus*, Lam., *Cheiranthus mutabilis*, L'Hérit., and many others have survived the last six winters unprotected; while large bushes of Laurustinus, *Euonymus japonicus*, bay, &c., were evidently little, if at all, injured by the terrible winter of 1895. Yet, even within the limits of my own grounds, with a rise of only 35 feet up to the 400-feet contour line, there is a marked difference of climate. On November 27, 1904, in the upper part of the garden, dahlias planted within 4 feet of a high wall facing south were blackened by frost, while in the lower garden those in the open border were uninjured.

The difference between the climate of this place and the Public Gardens at Maidstone is fairly shown by the following comparative statement, the temperatures from the latter having been taken when I chanced to pass the place where they are put up, and therefore not selected :—

May 11, 1904	Max. in shade	Min. in shade	Min. on grass	Range in shade
Ulcombe ...	50°·0	39°·5	35°·5 (corrected)	10°·5
Maidstone	56·0	38·0	30·0	18·0
May 28 to 30, 1905				
Ulcombe, 28th	67·6	47·5	43·8	20·1
,, 29th	70·6	57·0	44·5	13·6
,, 30th	76·0	52·0	48·0	24·0
Maidstone, 28th	76·0	43·0	39·0	37·0
,, 29th	81·0	50·0	42·0	39·0
,, 30th	85·0	50·0	42·0	43·0

The maxima in both cases are those of the previous day. Maidstone is seven miles from here, and lies in the valley of the Medway.

Yet, in spite of the fact that the thermometer, even on the grass, has not been below 32° since April 3,[1] we are no better off for apples than our neighbours! The apples did not begin to flower until the end of April, so some other cause than frost must be found to account for the bad crop. This is an example of the difficulties of the question; other complications are the nature, mechanical and chemical, of the soil; period of blooming of different varieties of the same fruit; shelter from the generally prevailing cold winds in spring; &c. Still, some effort should be made to ascertain the conditions under which, on an average of years, the best crops can be obtained, and so avoid the waste of time, money, and land that has been incurred in hundreds of instances by planting orchards in unsuitable localities, while hundreds of acres of suitable land are used for corn and other crops that would grow as well elsewhere.

ALFRED O. WALKER.

Ulcombe Place, near Maidstone.

Islands for Weather Forecasting Purposes.

IN NATURE for June 1 is a very suggestive article by Dr. Lockyer under the above heading, in which specific reference is made to the meteorology of Western Australia. It is becoming increasingly evident that the Indian Ocean and its neighbouring continents form one of the most interesting fields in the world for the study of meteorology, and as the officer-in-charge of an important section of this region I am most anxious to assist in this study in any way possible. Our progress will be slow if we start with incorrect theories, and my present object is to point out the probable inaccuracy of a few of the fundamental concepts, and to indicate briefly a few of the observed facts which seem to have a bearing upon the whole matter.

There is little or no rain in Perth of a monsoonal character. The wettest months are May, June, July, and August, during which time the prevailing winds are *not* from the S. or S.W. Rain is almost always associated with the passage of a "low" along the south coast, setting in with the wind at N. or N.W., and *finishing* when the wind veers to S.W. and S.

There is a tendency throughout the year for the winds to alternate from the eastward during the forenoon to the S. or S.W. in the afternoon. This is most marked in the summer months, when the prevailing feature of the weather map is a "high" stretching along the ocean *south* of our coastline. How far south or west this extends I cannot say. The prevalence of southerly winds in the summer time is probably due to this anticyclonic area, and Fig. 2 on p. 111 is therefore somewhat misleading.

As the sun moves north the high pressure follows it, and in June and July forms a belt across the centre of Australia. It is, however, constantly on the move from west to east. A "high" will generally during these months strike the west coast about, or to the north of, Perth, and gradually work across to the eastern States. As it passes our wind sets in strongly from the eastward, gradually veering more northerly. By the time the "high" reaches, say, Adelaide, our wind is N.N.E., the isobars are running nearly parallel to the west coast, and we are looking out for a "low" to approach from the ocean. As a general rule, the "low" is first heralded from Cape Leeuwin, the extreme S.W. corner of Australia, but rain sets in with a N. and N.W. wind all along our west coast as far as the N.W. cape. It is heaviest in the extreme S.W. The "low" generally passes south of Cape Leeuwin and across the bight to Tasmania. So long as our wind, and especially that at the Leeuwin, has any *northerly* component, we are pretty certain to have more rain, but as soon as it reaches W.S.W., and especially S.W., we anticipate clearing weather.

Whence these "lows" come before they reach us is therefore a question of great importance. I believe the usual theory upon this point is incorrect. That is, that these "lows" are northerly extensions of the Antarctic low-pressure belt, which sweep past the Cape of Good Hope, and after the lapse of a few days reach Cape Leeuwin, and so travel along the south coast of Australia. I think this is incorrect for several reasons. In the first place, I have endeavoured to trace notable storms either forward from the Cape to Australia, or backwards from Australia to the Cape, and have not been able to find any connection whatever. Secondly, from theoretical considerations, a rotating body of air in the latitude of the Cape would possess a sufficient southerly component to its motion of translation to carry it well south of Australia. Thirdly, the more direct evidence stated in the next paragraphs.

During the summer months, January, February, and March, there is a class of storm which strikes our N.W. coast and then travels across the State in a S. or S.S.E. direction, emerging in the Great Australian Bight, and travelling thence in an E.S.E. or S.E. direction towards Tasmania. Before striking the N.W. coast it can sometimes be traced from the extreme north of the State moving towards the S.W., down the coast, but keeping well out to sea, then gradually recurving, and striking the coast about lat. 20°. The existence of this class of storm and its approximate path is now beyond doubt, though until recently it was ignored in practical Australian meteorology. I think, however, it would now be safe to say that it dominates the weather of at least the western and southern portions of Australia during the summer months, though on account of the paucity of stations in its track our knowledge of the various conditions is at present elementary. It is important to bear in mind that the study of Western Australian meteorology is in its infancy. Not until the last few years was the importance of this class of disturbance recognised, and therefore any theories which had been formed require to be modified. During the last two years evidence seems to me to be accumulating that this particular class of storm persists throughout the year, and is, in fact, the dominating influence in Australian meteorology. If this be so, it can easily be seen how profoundly older theories are affected, and how necessary it becomes to make a fresh start.

Even during the summer the disturbances do not all follow along the same track. Sometimes they strike the coast near or even south of the N.W. cape, and occasionally they just miss the coast, but can be traced, following it down, but keeping out to sea, and eventually rounding Cape Leeuwin and behaving like an ordinary winter storm. It is this latter path to which I wish to direct special attention.

In the winter, as a general rule, the first intimation of an approaching "low" is obtained from Cape Leeuwin,

[1] Yet severe frost with great damage to crops in the Dartford, Rochester, and Hoo districts; also at Maidstone and Sevenoaks on May 22–3, is reported in the *Kent Messenger* of May 27.

and the storm centre invariably passes to the south of that spot. It was but natural, therefore, to suppose that the storm came from the W. or W.S.W. of the Leeuwin, and the winter and summer disturbances have been regarded as two distinct varieties. Within the last two years, however, circumstances have been noted which seem to show that there is no real distinction between the two. In July, 1904, I first directed public attention to the fact that certain of our winter storms could be distinctly traced *down* the west coast, affecting N.W. districts first, and then travelling in a S. or S.S.E. direction. I have gone somewhat fully into this matter in my "notes" on the climate of Western Australia for the month of July, 1904, and when once the fact has been indicated it becomes easy to find numbers of cases when winter storms can be seen to have a considerable southerly component of motion. Only a few days ago, for instance, a disturbance struck the N.W. coast in about lat. 20°, and travelled in a S.E. direction across the State, giving rain just along the fringe of our most eastern settlements, probably much heavier in the interior desert, and causing a heavy downpour in South Australia from the centre to the south coast. Again on May 20 a disturbance approached the N.W. cape, causing rain there, next day being definitely located in the ocean a little to the S.W. of Perth, and certainly considerably north of Cape Leeuwin, then continued to travel down the coast, rounded the Leeuwin, and behaved thenceforward just like any other winter disturbance.

There is, therefore, plenty of evidence that "lows" do travel down the Indian Ocean, even in the winter months, in a southerly or S.E. direction towards Cape Leeuwin, and probably all, or nearly all, of our storms come in this way. If this be so, the charts on p. 111 are misleading. Our rain certainly does not come mainly with a S.W. or S. wind, nor is there (probably) any stationary "high" as marked. Instead there is a series of "highs" moving towards our west coast, broken up by a series of "lows," which pass between and make for the extreme S.W. corner of Australia. The weather which we specially desire to predict comes with these "lows." Several things follow from this. One is that the Amsterdam and St. Paul Islands are far too much to the southward to be of any use to us for practical forecasting purposes, though a few years' records from there would be exceedingly valuable. Another is that Dr. Lockyer's theory about the S.E. trades and S.W. monsoon requires some modification, though it is very probable that the Indian and Australian weathers are inter-dependent and require to be studied together. A third is that Sir John Eliot's proposal for an Empire study of meteorology ought to be acted upon as soon as possible, and all our observations coordinated to some definite purpose. A fourth is that, failing this, Australian meteorologists ought to make every effort to bring about the establishment of a central Australian bureau for the study of scientific meteorology, as recommended at the recent conference held in Adelaide.

W. ERNEST COOKE.

Perth Observatory, Western Australia, July 3.

DUTY-FREE ALCOHOL.

HOW far the trade in synthetic colours and fine chemicals has been lost to the country through the heavy customs restrictions placed upon the use of alcohol is a question which has been agitating manufacturers for many years past. On the one hand, we are told that the entire chemical trade has been diverted from our shores because of the high cost of alcohol; on the other, that the alcohol question has very little to do with the matter. After the agitation for the use of duty-free alcohol had been going on for some years, and owing to its increasing intensity and to the pertinacity of a few, the Government in the autumn of last year appointed a departmental committee to take evidence in order to find out whether the high duty on alcohol really was the factor which caused the practical extinction of the aniline dye industry and accounted for our inability to found an industry in fine synthetical products. The committee commenced to take evidence on November 8, 1904, and finished on February 17 of this year.

More is heard about the loss of the synthetic colour trade to the country than about the loss of any other industry, or about the failure to establish new industries which flourish on Continental or American soil. The loss of the coal-tar colour industry is variously ascribed to incompetence on the part of our manufacturers and their failure to realise the importance of employing—and paying for—highly trained scientific chemists, to our patent laws, to trade protection abroad, and to the excessive duty charged upon alcohol in this country. The report with which we are at present dealing has to do with the last question—duty-free alcohol. A careful perusal of the questions to, and the answers of the witnesses before the commission, which included most of the well-known names in the coal-tar colour industry in this country, does not convince one that this special industry has been lost to the country owing to the high cost of alcohol.

The amount of alcohol used at the present day for preparing the dyes is not very large. At one time many of the dyes were sold as alcoholic extracts, and alcohol was somewhat largely used in the preparation of the products. Since the introduction of the azo dyes, however, alcohol is not nearly so largely employed as formerly. There are, indeed, certain dyes in which the methyl or ethyl radical is introduced during the process of manufacture, and these require the employment of methyl or ethyl alcohol in their preparation, and, of course, in this case the alcohol cannot be recovered; for example, the dyes in which dimethyl aniline is the starting product. British manufacturers who desire to make these colours import all the dimethyl or diethyl aniline from abroad. It came out, however, in the evidence that one large aniline dye company which desired to manufacture dimethyl aniline obtained Government sanction to employ methyl alcohol mixed with one-twentieth of 1 per cent. of mineral naphtha—"a condition which the company stated would suit their purposes." Although from the evidence before the commission it appeared that there was "a substantial profit to be made upon the manufacture of dimethyl aniline," for some reason or other it was never manufactured.

Reviewing the evidence of the different persons connected with the coal-tar dye industry, one is brought to the conclusion that, although the high price of alcohol has militated against the success of the industry, yet there are other even more potent factors which have prevented the industry being successful. Manufacturers, with a few isolated exceptions, have not even been successful in meeting Continental competition in dyes which do not require the use of alcohol. Prof. Green probably came very close to the truth when he said, in reply to a question as to what he considered the cause of the decline of the coal-tar colour industry:—

"They (the manufacturers) did not realise the great importance of research; the great importance of theory. They expected to see an immediate result from experiments, and if they did not get an immediate result they considered that they were wasting their money. They did not employ a sufficient number of research chemists, and they did not pay those research chemists they had to encourage them to remain. . . . There may be other contributory causes, such as the patent laws and this question of the spirit."

There seems to be a strong consensus of opinion that in the xylonite and gunpowder manufactory leave to use pure alcohol is much to be desired. Xylonite when made with methylated spirit is inclined to darken, and there is thus a difficulty in

making materials which should be white or ivory coloured.

In the gunpowder manufactory, if pure alcohol were used to dehydrate the material the dangerous drying process by heat could be done away with, because the material moistened with alcohol can be directly placed in the mixers containing acetone, &c., the moistness due to alcohol not interfering with the process of manufacture, whereas that due to water is harmful. For making so-called "condensed" powders which are totally dissolved in the solvent the action of methylated spirit is objectionable; as one of the witnesses stated, "you cannot control the surface of the grain with a methylated-ether mixture in the same way that you can with a pure alcohol-ether." To a large extent the lack of initiative on the part of British powder manufacturers may be indirectly attributed to the high cost of alcohol. Some lacquer manufacturers and users of lacquers state that lacquers made from pure alcohol are very much superior to those made from methylated spirit. Mr. Bagley, the witness from Messrs. Samuel Heath and Sons, the largest brass-founders in the world, stated that, although they are easily able to compete with Continental manufacturers so far as their brass ware is concerned, their goods are often not acceptable because of the want of durability and finish of the lacquering. The lacquer costs something about 4*s.* per gallon, but they can, by paying 32*s.*, obtain a lacquer made with absolute alcohol, and this is as good as the best foreign lacquer. The witness said he was ashamed to have to confess that they could not obtain the fine finish which the Germans produced, and, as regards the French importers, they absolutely refused to take lacquered articles, but bought them unlacquered and finished them themselves. This witness was of the opinion that the foreign lacquers were made with pure alcohol, but it was subsequently pointed out by the chairman that even abroad it was denatured. On the other hand, Mr. Gardiner, the manager of the firm of Messrs. A. Lambley and Sons, said that they not only could make lacquers as good as Continental manufacturers, but that they had a large export trade and had no difficulty in meeting Continental competition; they very rarely used pure alcohol for making lacquers.

From the extremely contradictory evidence of these two witnesses it would appear that it is more a matter of method or knack in the manufacture than of methylated or pure alcohol which determines the quality of the lacquers.

There seems very little doubt but that the manufacture of fine chemicals and synthetic perfumes is considerably interfered with owing to the British manufacturer not being able to use duty-free alcohol. When methylated alcohol is employed for crystallising the substances there is invariably a peculiar and disagreeable odour attending the finished product. But if the manufacturer, in order to get over this difficulty, employs duty-paid absolute alcohol, the increased cost of manufacture is prohibitive. It was stated in evidence, for example, that with regard to the manufacture of phenacetin "the duty on the spirit would come to 140*l.* on 100*l.* worth of the article as imported."

Chloral hydrate is another substance which cannot profitably be made in this country. In the manufacture of ether from methylated spirit Mr. David Howard stated that "if we might have pure methyl alcohol and pure ethyl alcohol, it would be a beautiful thing to make ether of. But the result of the ketones and other bodies in it is that the sulphuric acid gets in a most horrible mess, and we get abominable compounds which I have never been able to excite the interest of any chemist in yet; but they are a very great disadvantage."

Those connected with the motor-car industry and the use of alcohol for motor engines in place of petrol seemed to consider that very much better results can be obtained with pure alcohol than with methylated spirit. A perusal of the evidence leads to the conclusion that further experimenting in this direction would be advisable. One is certainly inclined to the opinion that the presence of bases would be harmful, as these would probably on combustion be converted into products which would corrode the metal work. Of course, if alcohol is to be employed for motor purposes it would of necessity require to be denatured, because it would then be sold in large and small quantities at every little oil-shop in the kingdom. If motor-engineers wish to build alcohol engines they will have to experiment with all sorts of denaturants, and, doubtless, the excise authorities would aid them in their endeavours.

In reading through the report one is struck by the repeated reference which is made to the relative cost of pure *duty-free* alcohol in the United Kingdom and in Germany; British manufacturers do not seem able to compete in the manufacture of alcohol with their German rivals even when working under equal conditions. Further, it is a well-known fact amongst chemists that it is practically impossible to get really good absolute alcohol of British manufacture. It is a remarkable fact that traces of impurities which one can barely find by analysis interfere very much with the smooth working of reactions in which alcohol is employed. This fact came out again and again in the evidence of witnesses before the committee. Those on the committee who were there to look after the interests of the excise endeavoured with great skill to shake the evidence on this point, explaining that if the quantity of an impurity was only a fraction of a per cent., it surely could not possibly cause all the mischief attributed to it. The invariable reply was, the product when made with absolute alcohol has such and such properties, but it is either impossible or a matter of extreme difficulty to obtain the same results with methylated spirit.

On the other hand, in a good many cases it appeared that sufficient experimental work had not been tried. Methylated spirit had been condemned for manufacturing this or that article, but little or no attempt seemed to have been made to try spirit denatured in other ways or to try the use of other solvents. By the Act of 1902 manufacturers were allowed to suggest other means of denaturing the alcohol, and in some cases at least the excise authorities had been very willing to aid them in their efforts. As a matter of fact, in manufacturing operations in Germany it is rare for absolute alcohol to be employed, the alcohol generally being denatured in a way which suits the particular manufacturer. Of course, where the use of pure alcohol is absolutely necessary the German has a much lower excise duty to compete with than the British manufacturer. That excise restrictions, the high duty on alcohol, and a considerable amount of red tape have, in some cases, made the manufacture of certain products—so as to compete with the foreign manufacturer—almost an impossibility there can be no doubt. But why that should hinder British manufacturers who manufacture products in which alcohol is not employed it is not easy to see.

If instead of calling in an outside "expert" (?) when an emergency arises the manufacturers were to employ a certain number of well-trained chemists, men who, after being on the staff for a short time, should be far and away superior to outside experts, there is but little doubt that fewer emergencies would

arise and that a progressive and ever-improving concern would be the result. There was a great deal in what Dr. Nichols said in his presidential address to the Society of Chemical Industry—the quotation is from memory—"Never put up duplicate plant; no plant is so perfect that it cannot be improved; after a plant has been in use a short time certain points in which it may be improved are sure to be discovered."

So if we are to compete with foreign competition no process should be worked year after year by rule of thumb, otherwise manufacturers will find their product being pushed out of the market by a similar but improved product in which the brain has been the motive power for the thumb.

It is very much to be hoped that now that the matter has been thoroughly threshed out the Government will step in and—while safeguarding its own interests and the sobriety of the workers—it will aid manufacturers by all means in its power by enabling them to use a class of alcohol which will be suitable to their special needs.

F. MOLLWO PERKIN.

THE GEOLOGY OF SOUTH AFRICA.[1]

TOWARDS the end of last century it appeared as if England had lost her well earned supremacy in geological research in Africa. In Germany, elaborate treatises dealing sometimes with her own African colonies exclusively, and sometimes with that of neighbouring British territory, monthly and almost weekly appeared. French geologists, too, produced essay after essay on their African colonies and possessions. Meanwhile, England was apparently content to lag behind.

It is fitting that the visit of the British Association to one of our most famous and most remote African colonies this year should witness the publication of two geological works, of the highest scientific standing, written by our own countrymen. Early this year, the comprehensive treatise by Mr. A. W. Rogers on the geology of Cape Colony made its appearance. Now, a few months later, we have presented to us the philosophic *résumé* of the geology of South Africa as a whole by Messrs. Hatch and Corstorphine.

Both volumes supply a long-felt want. In their method and conciseness both are equally British.

In a work treating with the richly metalliferous regions of the Transvaal it might have been expected that questions of economic interest would occupy many pages. It is an agreeable surprise to find that this is not the case. On the contrary, the geology of South Africa is here described in a thoroughly scientific manner, clearly and concisely worded. All essential details are brought within a compass of 312 pages of text.

In the opening chapter, on the history of research, ample recognition is given to A. G. Bain, the father of South African geology, and also to Stow. More recent workers cannot complain that their investigations have been neglected.

The book is divided into five parts. Part i. deals with the pre-Karroo rocks, in which those of southern Cape Colony are described in section i., and those of northern Cape Colony, the Transvaal, &c., in section ii. This separation into sections becomes necessary owing to the want of similarity in the succession of the pre-Cape rocks in the two regions.

The authors naturally give somewhat more space to the sequence in the Transvaal, more especially to a description of the upper division of the Witwatersrand system, which includes the famous "Banket." It is interesting to find that the stratigraphical position and age of this well known deposit remain unsolved, except that the authors consider the age to be vastly newer than the Archæan rocks and greatly older than the Table Mountain Sandstone.

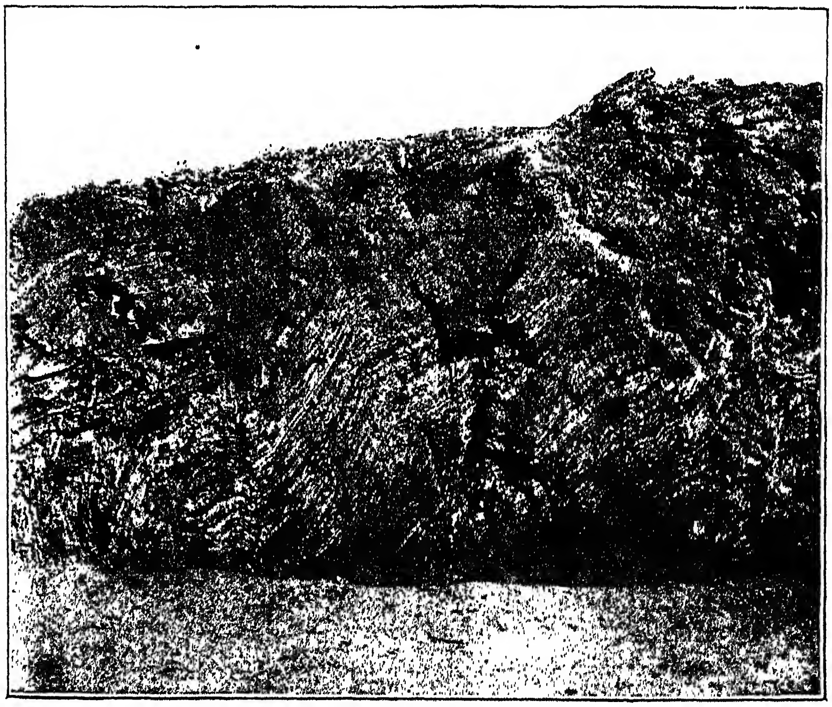

FIG. 1.—Contorted Band, Hospital Hill Slate, Show Yard, Johannesburg. From "The Geology of South Africa," by F. H. Hatch and G. S. Corstorphine.

The complicated nature of the stratigraphy of South Africa, other than that of the peninsula, will be gathered from the following tables:—

North of Cape Colony	Transvaal
Dwyka Conglomerate	Dwyka Conglomerate
Unconformity	*Unconformity*
Matsap Series	Waterberg Series
Unconformity	*Unconformity*
Griqua Town,	Pretoria Series
Campbell Rand and Keis Series	Dolomite and Black Reef Series
Unconformity	*Unconformity*
Volcanic Series	Ventersdorp Series
Unconformity	*Unconformity*
	Witwatersrand Series
	Unconformity
Namaqualand Series	Swaziland Series

This table opens up a vista of infinite possibilities.

The Karroo rocks are adequately dealt with in part ii., but in this and elsewhere Rhodesia,

[1] "The Geology of South Africa." By F. H. Hatch and G. S. Corstorphine. Pp. xiv+336. (London: Macmillan and Co., Ltd., 1905.) Price 21s. net.

Bechuanaland, and Natal receive scant notice. The coastal system, including the Uitenhage and Umtavuna Cretaceous rocks, profusely illustrated with typical fossils, occupies part iii.

The superficial deposits, somewhat summarily dismissed, form a separate chapter. Many of the interesting problems connected with them are not even hinted at. A classification by chemical composition is adopted.

The igneous and volcanic rocks, which take so large a share in South African stratigraphy, are described in connection with the systems with which they are more intimately associated.

Part iv. briefly discusses the igneous rocks of doubtful position. Too much space has here been allotted to the diamond-bearing deposits.

Part v. discusses the correlation of the South African strata. It contains much information guardedly expressed. This portion possesses the almost unique virtue of stating the arguments in favour of the correlation adopted by the authors. Few geologists will now dissent from the view that the Witwatersrand series is older than the Table Mountain Sandstone and newer than the complex of rocks termed Archæan.

Latter-day geologists will miss a chapter on structural and dynamical geology. The authors, and many will no doubt agree with them, have eschewed the problems entailing the use of modern physiographical and dynamical terminology. In dealing with rocks and fossils they have, however, occasionally been compelled to drop into technical language. Thus we met with *Cardium bullen-newtoni, Eriphyla rupert-jonesi* among fossils; while among minerals and rocks several of those mentioned wordily lengthen out what, to the general reader, would otherwise be a welcome page.

The authors have certainly succeeded in their self-imposed task "to correlate and systematise the valuable results of both official and private work." They are right in considering that what we know of South African geology lacks coherence. The best efforts, such as that of the authors, must for a long time be regarded as tentative and by no means final.

The volume is profusely and admirably illustrated with photographs of scenery and rock sections. Two coloured geological maps accompany the text, one of South Africa between Bechuanaland and the east coast and the Transvaal and the south coast, and one of the Transvaal. It is to be hoped that the half-mourning adopted for the Karroo system will not be perpetuated. Economically it is false; artistically it is ruinous.

W. G.

NOTES.

THE meeting of the French Association for the Advancement of Science was opened on August 3 at Cherbourg under the presidency of Prof. Giard.

WE regret to learn that Prof. L. Errera, professor of botany in the University of Brussels, and member of the Royal Academy of Belgium, died on August 1 at Uccle.

WE understand that the editorship of the "Fauna of British India," rendered vacant by the death of Dr. W. T. Blanford, has been offered by the Secretary of State for India to Lieut.-Colonel C. T. Bingham.

A REUTER telegram from Rio de Janeiro says that the Latin American Scientific Congress was opened on August 7, delegates from all the South American Republics being present.

THE sixth International Congress of Criminal Anthropology is to take place in Turin on April 26 next under the presidency of Signor Bianchi, Minister of Public Instruction.

PROF. RONALD ROSS and Prof. Boyce, of the Liverpool School of Tropical Medicine, will sail for New Orleans on Saturday to assist in dealing with the epidemic of yellow fever in that city.

WE regret to see the announcement that Mr. Alexander Bell, father of Dr. Alexander Graham Bell, and an active worker in educational science, especially in relation to the study of deaf-mutes, died at Washington on August 6.

MR. CHRISTOPHER HEATH, Emeritus professor of clinical surgery in University College, London, and a former president of the Royal College of Surgeons of England, died suddenly on Tuesday, August 8. Mr. Heath was the author of several standard works on surgical subjects.

THE Amherst College expedition for the observation of the eclipse of the sun on August 30 has departed for Tripoli, where the instruments will be mounted on the edge of the desert. The members of the expedition are Prof. David Todd, Mrs. and Miss Todd, and Mr. E. A. Thompson, and their attention will be chiefly devoted to the photography of the corona and of intra-Mercurial planet regions.

THE Treasury has renewed for a further period of five years the annual grant of 500*l*. to the British School at Athens. The promoters of the movement hope that an influentially signed petition for a similar grant to the British School at Rome may be also favourably considered.

PROF. GUIDO CORA informs us that the earthquake disturbances registered at the Pola Hydrographic Station on July 23 (see p. 298) were also recorded at the Osservatorio Ximeniano of Florence at 3.50 a.m. on the same date. Father Guido Alfani, from an examination of the seismograms, expressed the opinion that a severe and protracted earthquake must have taken place at an estimated distance of about 6800 kilometres (4225 miles).

WE notice with regret the death on July 26 of Prof. Bichat, dean of the faculty of sciences at the University of Nancy. Prof. Bichat was also director of the Electrotechnical Institute of Nancy, and took a very active part in all efforts for the improvement of secondary and higher education.

THE research fellowship in chemistry offered by the Worshipful Company of Salters, and tenable in the research laboratory of the Pharmaceutical Society, has this year been awarded to Miss Nora Renouf, who has been engaged in research work for the past two years in the society's laboratories. The Salters' fellowship is of the annual value of 100*l*., and was founded with the view of encouraging the application of the newest methods of scientific chemistry to the elucidation of pharmacological problems.

THE International Congress of Anatomy was opened in the morning of August 7 at Geneva. Three hundred representatives of the principal universities of Europe and America were present, including office-bearers of the five great anatomical associations of Great Britain, France, Germany, Italy, and the United States. One hundred and fifteen papers on various scientific subjects were put down for reading. The congress will conclude to-day with a banquet given by the city of Geneva to the delegates. The congress has accepted an invitation to assemble at Boston in 1907.

THE *Journal of the Royal Microscopical Society* for June contains two papers by Mr. J. E. Stead, F.R.S., one dealing with micro-metallography in general, and the other with the special processes for detecting phosphorised portions in iron and steel.

THE two articles in the July issue of the *Irish Naturalist* are devoted to local subjects, the Rev. Canon Norman completing his list of Irish ostracod crustaceans, while Mr. R. Ll. Præger discusses the distribution of fumitories in Ireland.

WE have to acknowledge the receipt of a complete copy, with the plates, of the first part of vol. lvii. of the *Proceedings of the Philadelphia Academy*. Many of the papers contained in this part have been already noticed in our columns, as they appeared in the monthly issues.

WE have received a fasciculus of "Illustrations of the Zoology of the *Investigator*," containing plates of crustaceans (part xi.) and fishes (part viii.). Special interest attaches to the plate of the crab *Lithodes agassizi* on account of the large size and peculiar form of this species, and also to the plates of deep-sea fishes, a few of which have only recently been described.

MR. J. E. ROBSON continues his catalogue of the Lepidoptera of Northumberland and Durham in vol. xv., part i., of the Natural Transactions of the aforesaid counties, dealing in this instance with the groups Pyralidina and Tortricina. Both these sections of the Microlepidoptera are but little studied by collectors, and the author confesses to considerable difficulty in dealing with the second of the two.

IN No. 1410 of the *Proceedings of the U.S. National Museum* Mr. E. Linton describes certain cysts of a cestode worm from a bottle-nosed porpoise, which are regarded as indicating a new species of Tænia. No. 1404 of the same publication contains the first part of a description, by Mr. C. B. Wilson, of the North American parasitic copepod crustaceans of the family Caligidæ. An account of the Argulidæ has already appeared in the same journal; the members of the present group are regarded by the author as of the greatest possible ecological interest, so that the study of their life-history cannot fail to yield important results.

ARTICLE 7 of vol. xx. of the Journal of the College of Science of Tokyo University contains an account by Dr. I. Ijima of the larva of an apparently new cestode worm which was recently found infesting a Japanese woman in extraordinarily large numbers. This larva has been provisionally described as a new generic and specific type under the name of *Pterocercoides prolifer*. It is believed to be a member of the Bothriocephalus group characterised by the absence of "bothria," a feature probably common to Ligula, with which the Japanese cestode may prove to be nearly related.

IN a paper published in the fourth volume of series iii. of the *Anales* of the National Museum of Buenos Aires, Dr. F. Ameghino records the presence of a perforation in the astragalus of the badger, the other living mammals in which this feature is known to occur being the dasyure, the giant armadillo, and the mole. The same volume contains a paper by Mr. F. Lahille on a new type of scombroid fish from Argentine waters, which has been named (in a preliminary notice published a couple of years ago) *Chenogaster holmbergi*. This fish, of which an excellent coloured plate accompanies the memoir, is a member of the same group as the New Zealand Lepidothynnus and Gasterochisma, which inhabit the same latitude as Chubat. From the New Zealand forms Chenogaster differs by the united dorsal fins, while it is distinguished from Gasterochisma by the small ventral fins and from Lepidothynnus by the presence of vomerine teeth. The three genera indicate a circumpolar Antarctic group.

ON a previous occasion a special notice was given in this Journal of Dr. Waite's account of the nesting habits of the fighting fish (*Betta pugnax*), as observed in an aquarium. In the *Records of the Australian Museum* (vol. vi., part i.) Dr. Waite publishes a preliminary note of these habits in the allied paradise, or rainbow, fish (*Polyacanthus opercularis*), of which specimens have likewise been successfully kept in captivity. After mentioning that at the commencement of the breeding season the male assumes a gorgeous nuptial coloration, the author goes on to say that the nest of this species is simpler and flatter than that of the fighting fish, a difference probably due to the habit of the former of nesting beneath shelter. The first eggs are often laid in a small mass of bubbles, others being added later; in consequence of this the eggs are raised quite out of the water, and thus hatched. It may be added that, according to older views of nomenclature, the name Polyacanthus renders void that of Polacanthus, applied many years later to a British dinosaur.

THE migrations and growth of plaice form the subject of a communication by Mr. A. Meek to vol. i., part ii., of the new series of the *Transactions of the Natural History Society of Northumberland and Durham*. After referring to previous experiments and observations, the author states that during last year 483 plaice (inclusive of a few other flat-fishes) were caught, marked, and returned to the sea on the Northumberland coast. Of these fish 52 were recovered; and among this number only 2 made conspicuous migrations, and only 7 may be said to have left the bays where they were liberated. Apparently, the small plaice on the Northumberland coast gradually travel from the sandy pools to the adjacent deeper water, where they spend the remainder of their immature condition. When four or five years old they migrate into the still deeper extra-territorial waters, and apparently show a constant tendency to reach increasing depths with advancing age.

A RESTORATION of one of the huge Miocene American perissodactyles of the family Titanotheriidæ is attempted by Prof. R. S. Lull in the July number of the *American Naturalist*, the species in question being a member of the genus or group Megacerops. The creature stands about 7 feet 4 inches at the withers, and measures rather more than 12 feet in length. The general proportions are those of a rhinoceros, although the limbs, probably to support the enormous weight of the body, are less angulated, and primitive features are displayed by the shortness of the back and in the structure of the fore-foot. Indeed, if we are to accept Prof. Lull's description of the latter, the definition of the group Perissodactyla requires modification, for the fore-foot of this titanothere is stated to be four-toed and symmetrical, with the main axis lying between the third and fourth digits after the artiodactyle fashion. As regards the nasal horns, which are branched at the summit, the author is inclined to believe, from the absence of groovings on the bone, that

the basal portion (which is all now remaining) was clothed with skin during life, and that upon this were growths comparable to the horns of modern rhinoceroses.

PROF. ALBERT M. REESE, of the Syracuse University, has gone to Florida, under the auspices of the Smithsonian Institution, says the *Scientific American*, to collect eggs of the alligator with which to work out its embryology; subsequently he will spend some time at the biological laboratory of the Carnegie Institution of the Dry Tortugas studying the material he collects. Twenty-five years ago alligators existed in great abundance in the region ranging from North Carolina to the Rio Grande of Texas, but as alligator leather became fashionable about that time the demand thus created has reduced the supply by at least 98 per cent. It is said that a person may travel now from Jacksonville to Miami, Fla., without seeing a single alligator. It is estimated that 2,500,000 alligators were killed in Florida from 1880 to 1894.

THE list of new garden plants for the year 1904 has been published as appendix iii. to the *Kew Bulletin*. This list not only affords information respecting new plants, but also gives official authentification to the names, thereby providing an accurate guide for horticulturists.

A REVISION of the genus Zexmenia, prepared by Mr. W. W. Jones, has been issued as No. 7 of vol. xli. of the *Proceedings of the American Academy of Arts and Sciences*. The genus is one of the helianthoid Compositæ restricted to tropical and subtropical America.

NATURE-STUDY, so far as it is founded on the four faculties of observation, deduction, memory, and constructive imagination, is closely allied to the methods of Sherlock Holmes; such is the gist of an article by Mr. Lamborn in the May number of the *Nature-study Review*, and teachers in search of a novelty in nature-study may be referred to the example which is quoted. A short article on observation bee-hives for the schoolroom, by Miss Comstock, suggests another line of work. There is also much truth in the reasons which Mr. L. A. Hatch assigns for failure in teaching the subject, the first and foremost being a want of the observational instinct.

THE *Indian Forester* for June contains many interesting articles relating to forestry and kindred subjects. A new species of Diospyros (*D. Kanjilali*) is described and figured by J. F. Duthie. An article on the prohibition of grass burning and its effects on the game of the country will be read with interest by both forester and sportsman. Another valuable illustrated article, entitled "Some Facts about Gutta Percha," by Mr. A. M. Burn Murdoch, contains a great amount of useful information, especially regarding the rubber trees of the Federated Malay States. The article gives a very clear idea concerning the species and their distribution, the measures adopted for their protection, together with harvesting, manufacture, and properties of the gutta percha. There are many other papers and reviews, together with matters of general interest, which will repay perusal by those interested in forestry and its sister subjects.

THE broad-minded view which the U.S. Department of Agriculture takes of its function for instituting inquiries is well exemplified in three bulletins which have been received from the Bureau of Plant Industry. In Bulletin No. 68 Mr. A. S. Hitchcock presents a carefully prepared classification of North American species of Agrostis. The author, in the preparation of this memoir, has consulted all the large herbaria in Europe; the number of species, including three new to science, is limited to twenty-seven, and these, together with the principal varieties, are fully described and illustrated. A method of exterminating Johnson grass by means of a root-digger is explained by Mr. W. J. Spillman in Bulletin No. 72, and the problem of range management in the State of Washington is discussed by Mr. J. S. Cotton in Bulletin No. 75. The latter pamphlet deals with the protection and seeding of land which had been over-grazed by nomadic stockmen. Experiments on land situated at an altitude of 5000 feet demonstrated that Timothy, brome-grasses, and tall fescue would be found suitable for sowing on these mountain pastures.

WE have received a copy of the year-book of the Norwegian Meteorological Institute for 1904, containing hourly observations of air pressure and temperature for Christiania, in addition to observations made three times daily, and monthly and yearly summaries at a number of other stations in Norway. There is also a valuable appendix showing the departures of the monthly and yearly values from the normal at a number of stations for each year from 1874 to 1904. Since 1903 the station at Bergen has undertaken the duties of weather prediction and storm warnings for the western part of Norway. This arrangement allows Prof. Mohn, director of the Norwegian Meteorological Institute, to devote more attention to general climatology, and is conducive to more rapid dissemination of forecasts of the depressions arriving from the Atlantic.

THE *Annuaire météorologique* of the Royal Observatory of Belgium for 1905, published under the superintendence of M. A. Lancaster, director of the Belgian Meteorological Service, contains a large amount of useful information relating to that country in particular and to meteorological science generally. For sixty-eight years the *Annuaire* referred to astronomy and meteorology combined, but since 1901 each of these sciences is separately dealt with. Some 240 pages of the work now in question contain valuable data relating to the variability of atmospheric pressure and rainfall for each month since 1833, and to the frequency of sunshine since 1886. The following contributions are worthy of special notice :—(1) A discussion of the late spring and early autumn frosts by Dr. Vanderlinden, containing valuable particulars as to the conditions under which they generally occur, and the possibility of foretelling their occurrence. (2) A bibliography of meteorological treatises by M. L. Vincent from the earliest times. The author gives most attention to general treatises, but anyone wishing to study special subjects, *e.g.* marine, agricultural, and medical meteorology, or weather prediction, will find it an invaluable guide. (3) A collection of meteorological and physical constants and conversion tables which will be found exceedingly useful for general reference.

CAPTAIN H. G. LYONS contributes to the *Geographical Journal* for August an instructive summary of the dimensions of the Nile and its basin. The length of the Nile is given usually as 5400 kilometres (3355 stat. miles) to the centre of Lake Victoria, or 6000 kilometres (3728 stat. miles) for the continuous water-way from the source of the Kagera to the sea; the area of its basin is given as about 2,900,000 square kilometres (1,119,737 square miles). It is now possible to measure the length of the river with sufficient accuracy to furnish a value which later surveys probably will not materially alter. The length of the Nile from Ripon Falls to Rosetta mouth is 5589 kilometres, or 3473 miles. The area of the catch

ment basin has been calculated from a map on the scale 1 : 4,000,000 for the Sudan and Uganda, and from one of 1 : 2,000,000 for Egypt. The area of catchment of the Nile basin is 2,867,600 square kilometres (1,107,227 square miles). The area of the basin will vary according to the distance to which its limits are considered to extend on the west of the Nile northwards of Khartum. Captain Lyons has taken it as far as the cliff of the desert plateau, or the first marked rise of the desert where the cliff is absent, probably, on the average, about 3 to 4 kilometres (2 to $2\frac{1}{2}$ miles) from the edge of the cultivation. The whole of the Nile basin below Khartum, and practically all the White Nile basin, are non-effective in increasing the river supply, since the occasional local cloud-bursts may be neglected. The Bahr el Ghazal, as has been shown by recent measurements of the volume discharged, is also practically non-effective.

MR. S. TETSU TAMURA has contributed to the *Monthly Weather Review* (February and April) two papers dealing with applications of the Fourier methods of analysis, one to ice formation and the other to the nocturnal cooling of the atmosphere.

A VERY compact form of direct-reading cymometer for the measurement of wave-lengths and frequencies in connection with electric-wave telegraphy is described by Prof. J. A. Fleming in vol. xix. of the *Proceedings of the Physical Society of London*. In the described form the cymometer can be used to measure not only the length of the outgoing wave from a sending aërial, but also the length of the wave being received. The instrument can further be used for measuring the capacity of a Leyden jar or the inductance of a circuit for high-frequency currents.

IN the *Journal de Physique* for May, M. Adrien Guébhard contributes a paper on photographic action, illustrated by curves showing the darkening due to development as a function of the time, and the superficial changes as a function of the sum of the causes producing them—as he calls it, the "photographic function." It is well known that the effect of greatly over-exposing a negative is to reverse the photographic action, sometimes producing a positive instead of negative impression. M. Guébhard discusses the theory that the photographic function, after reaching its maximum and descending to a minimum, attains a second maximum, followed by a second minimum, and he describes experiments in support of this view.

PROF. O. ZANOTTI BIANCO, of Turin, has published (Florence: L. S. Olschki, 1905) a short discussion on Dante's "Quaestio de Aqua et Terra" considered in the light of modern geodesy. The question as proposed by Dante was essentially whether the water of the terrestrial globe is anywhere higher than the land which emerges from it. This question resolves itself largely into what is the definition of height adopted. According to Dante's belief that the earth was a sphere, points would be at the same height if they were equally distant from the centre, and the fact that the earth is not spherical, but ellipsoidal, would thus afford, in effect, an answer to Dante's question according to which the sea-level is considerably higher at the equator than at the poles. This particular interpretation appears to be the one favoured by Prof. Bianco.

No. 29 of the monograph supplements of the *Psychological Review* contains the first part of a new series of "Yale Psychological Studies," edited by Prof. Charles H. Judd, a large part of which is devoted to a series of studies of eye movements in connection with optical illusions. The contributors are Messrs. C. H. Judd, Cloyd N. Macalister, W. M. Steele, E. H. Cameron, and Henry C. Courten. Some idea of the researches on eye movements may be obtained from the following necessarily fragmentary summary. In order to trace the movements of the eye during the fixation of different points in the visual field, a tiny speck of Chinese white was attached to the cornea, and kinematographs were taken showing its movements as the subject followed the various details of a diagram. This was applied in the case of several well known optical illusions in which the lines of figures appear distorted or equal lengths appear unequal. In another series of experiments the subject was made to record his impressions by a series of pin pricks.

IN the *Bulletin de l'Académie Royale de Belgique*, No. 5, p. 201, Prof. W. Spring describes experiments which he has made on the limit of visibility of fluorescence. A conical beam of light of great intensity was brought to a focus in solutions of fluorescein of gradually increasing dilution. Fluorescence was perceptible on an area equal to one square millimetre at the apex of the conical beam, when the solution contained 1×10^{-15} gram of fluorescein, but imperceptible when the solution was ten times more dilute. On the assumption that in the limiting fluorescent condition at least one molecule of fluorescein is present in each cubic centimetre of solution, the value 1×10^{-18} gram is calculated as the superior limit of the weight of a molecule of fluorescein, and $2 \cdot 5 \times 10^{-21}$ gram as that of the weight of an atom of hydrogen.

SOME interesting observations on the decomposition of silver oxide at high temperatures are recorded by Mr. G. N. Lewis in the current number of the *Zeitschrift für physikalische Chemie* (vol. lii. p. 310). The velocity of decomposition of the oxide, when heated at 330° C. to 350° C., is at first so small that no appreciable evolution of oxygen is observed during several hours. The rate of change increases rapidly, however, as decomposition proceeds, passes through a maximum, and then gradually falls to zero. Experiments carried out to elucidate the peculiar phenomenon indicate that the reaction is autocatalytic, the silver produced by the decomposition being the catalytic agent. Other substances, such as platinum black and manganese dioxide, are found to exert a similar influence on the rate of decomposition of silver oxide.

A CONTINUOUS series of articles on the radio-activity of the soil and of the atmosphere is being written for *Le Radium* by Prof. Geitel. These articles connect together the several original papers published by Prof. Geitel in conjunction with J. Elster, many of which have already received notice in these columns. The number of *Le Radium* for July 15 contains in addition an article on the results obtained by the use of radium in the treatment of cutaneous cancer. It is illustrated by some striking photographs.

IN a brief note in the current number of the *Atti dei Lincei* Prof. A. Righi states that, using an experimental method essentially different from that employed by Prof. McClelland, he has obtained results which fully confirm the connection maintained by the latter to exist between the atomic weight of a substance and the amount of secondary radiation which it emits when subjected to the β and γ rays of radium (compare NATURE, vol. lxxi., p. 543, and lxxii., p. 158). The method used was to measure the change of potential of a disc of the material suspended

in a vacuum when subjected to the radiation of radium. The disc being under two influences, namely, an increase in the negative charge owing to the impact of the β electrons and a loss of negative charge owing to the emission of a secondary radiation, the actual rate of accumulation of the negative potential measured inversely the rate of production of the secondary radiation.

THE Engineering Standards Committee has issued a report on the effect of temperature on insulating materials. A series of measurements showing the influence of temperatures ranging from 75° C. to 150° C. on the disruptive voltage, the resistance and the mechanical properties of the insulating materials used in industry, were made by Mr. E. H. Rayner at the National Physical Laboratory, by Messrs. Crompton and Co. at Chelmsford, and by Messrs. Siemens Bros. and Co. at Woolwich. The electrical properties of the materials do not seem to be greatly influenced by exposure at the temperatures given, but the material itself perishes on long-continued heating. An interesting point established is the extraordinary increase in resistance of the insulating substances which, owing to the removal of water, accompanies drying at 100° C. The price of the report is 5s. net.

AN interesting Parliamentary return just issued gives some particulars of the first three months' working of the Wireless Telegraph Act. Part of the return relates to licences, seventy-eight applications for which have been received; the majority of these are for experimental purposes, but a fair number are for commercial purposes. No less than four companies have applied for licences to establish stations to communicate with America; two of these have been granted, one is under consideration, and the fourth is offered with an alteration in locality. The paper also contains particulars of the working of the arrangement between the Post Office and the Marconi Co. It seems that 111 messages have been received by the Post Office for transmission to outward bound ships, of which 21 could not be delivered (in six cases at least through the senders' fault in transmitting after the latest guaranteed time). The number of messages received from ships at sea is 1655, which, if it does not represent a very great volume of business, still serves to show that the system is beginning to develop in practical utility.

A MOST interesting paper on a new carbon filament, read recently by Mr. Howell before the American Institute of Electrical Engineers, is published in the *Electrician* for July 28. The author claims to have produced a new allotropic modification of carbon, so different are the physical and mechanical properties of his filament, which is prepared in the following way:—An ordinary carbon filament made from a solution of cellulose is baked to as high a temperature as possible in an electric resistance furnace; it is then "flashed" in the usual manner, and afterwards again electrically baked. Although the first electrical baking considerably affects the final result, it seems that the graphite coating deposited during flashing undergoes a very marked change during the subsequent baking, which is especially remarkable considering the high temperature at which the deposit is formed. The filament possesses a very much lower specific resistance than ordinary filaments, and this is a disadvantage from the point of view of practical lamp making; but, on the other hand, the resistance-temperature curve rises instead of falls, which is a distinct gain, and will undoubtedly confer on the lamp an indifference to fluctuations of line voltage, and so enable it to be run at a high efficiency. The inventor claims a useful life of 500 hours at a power consumption of 2·5 watts per candle, which is an extremely good result for a carbon lamp.

THE De La More Press will publish in the autumn "A First German Course for Science Students," by Prof. H. G. Fiedler and Dr. F. E. Sandbach.

WE have received a copy of the first volume of the "Collected Researches" of the National Physical Laboratory. The volume contains five contributions, viz.:—An analysis of the results of the Kew magnetographs on "quiet" days during the eleven years 1890–1900, by Dr. Charles Chree, F.R.S.; the high-temperature standards of the National Physical Laboratory, by Dr. J. A. Harker; the construction of some mercury standards of resistance, with a determination of the temperature coefficient of resistance of mercury, by Mr. F. E. Smith; the range of solidification and the critical ranges of iron-carbon alloys, by Dr. H. C. H. Carpenter and Mr. B. F. E. Keeling; and the resistance of plane surfaces in a uniform current of air, by Dr. T. E. Stanton. All the papers have been published previously, three of them in the *Transactions of the Royal Society* and two in journals of other scientific bodies. As Lord Rayleigh says in a preface to the volume:—"A multitude of other problems of scientific and technical importance press for solution. Some of these are already in hand, but the rate at which progress can be made will depend in great measure upon the amount of support which may be forthcoming from those more immediately concerned in the development of industry. It is hoped that the publication of the present volume may serve as a stimulus, by showing the character of the work of which the Laboratory and the Staff are capable."

PROF. N. ZARUDNOI publishes in vol. xxxvi. of the Memoirs of the Russian Geographical Society the herpetological and ichthyological results of his journeys in eastern Persia. The Reptilia are represented by 72 species, the Amphibia by 6 species, and the fishes by 17 species, many of which, especially among the first division, are new species described by Prof. A. M. Nikolsky.

THE last volume of the Memoirs of the Russian Geographical Society, for ethnography (vol. xxv., 1), contains a very valuable bibliography, by M. Baltramaitis, of everything that has been printed about Lithuania (8514 titles), its geography, history, law, statistics, and ethnography, including folklore. This volume, which covers 614 pages, is followed by an appendix, which contains a list of Lithuanian and old Prussian books printed from the year 1553 to 1903 (2665 titles). The whole is admirably indexed.

NOTICE is given by the Clarendon Press of the first part of a new book on "Elementary Chemistry," by Mr. F. R. L. Wilson and Mr. G. W. Hedley. According to the preliminary announcement which has reached us, the ultimate object of the authors is "the cultivation of a scientific habit of mind in the pupils, through the medium of chemistry, rather than the mere acquisition of the facts of science."

MR. JOHN HEYWOOD has published a fourth edition of Mr. R. L. Taylor's "Student's Chemistry." The book has been enlarged and revised by Mr. J. H. Wolfenden, and an appendix on the radio-active elements and an introduction to the study of organic chemistry has been added. The volume contains more than six hundred

questions and problems, and is likely to continue to be a popular manual on the outlines of inorganic chemistry and chemical philosophy.

MESSRS. MACMILLAN AND CO., LTD., have issued a new and revised edition of stage vi. of Mr. Vincent T. Murché's "Object Lessons in Elementary Science," the price of which is 2*s*.

A FIFTH edition of Mr. W. W. Fisher's "Class Book of Elementary Chemistry" has been issued by the Clarendon Press, Oxford. The text has been entirely revised, and numerous additions have been made. Several chapters on organic chemistry, intended to serve as an introduction to this division of the subject, have been included in the new edition, which is now in line with the present state of knowledge of the subjects dealt with in the volume.

OUR ASTRONOMICAL COLUMN.

JUPITER'S SIXTH AND SEVENTH SATELLITES.—A telegram from Prof. Pickering to the Kiel Centralstelle announces that Dr. Albrecht has observed the recently discovered sixth satellite of Jupiter with the Crossley reflector of the Lick Observatory. The times of observation and the determined positions were as follows:—

G.M.T.		Position angle		Distance
		°		′
1905 July 25·95	...	55·0	...	25·1
" 26·97	...	52·7	...	24·3
" 27·93	...	50·7	...	23·6

(Circular No. 77, Kiel Centralstelle).

In Bulletin No. 82 of the Lick Observatory Dr. Frank E. Ross publishes the following set of elements for the orbit of Jupiter's seventh satellite, which he has computed from the observations made by Prof. Perrine on January 3, February 8, and March 6:—

Ecliptic Elements.

Mean Jovicentric Longitude at Epoch	...	333·55	1905 Jan. 0·0 G.M.T.
Longitude of Perijove	...	336·65	
" Node	...	237·23	
Inclination to Ecliptic	...	31·0	
" Jupiter's Orbit ...	...	32·0	
Longitude of Node on Jupiter's Orbit	...	238·6	
Elements referred to Earth's Equator.			
Mean Jovicentric Right Ascension...	...	328·18	
Right Ascension of Perijove ...	...	331·28	
" " Node	...	281·13	
Inclination to Equator	...	26·2	

Mean Daily Motion $=1°·358$
log $a=8·9004$
$a=52'·54$ (for log $\Delta=0·71624$)
$e=0·0246$
$P=265·0$ days
Distance at maximum elongation $=70'$.

Calculating from these elements the positions at the times of Prof. Perrine's observations, it was found that the residuals were satisfactorily small, but for five intermediate dates, on which observations were secured, they proved to be larger than were expected. Dr. Ross accepts this result as evidence of the large periodic perturbations, chiefly solar, to which the satellite is subjected. The above elements indicate that this satellite revolves about Jupiter in a *direct* orbit, for although a retrograde orbit was computed and found to fit the three primary observations, it did not agree with the positions obtained from the intermediate observations.

An ephemeris, covering the period July 1 to November 13, from which the following positions are taken, accompanies Dr. Ross's paper:—

		p.	*s.*				*p.*	*s.*
		°	′				°	′
Aug. 10	...	294	26		Sept. 9	...	292	53
" 20	...	293	36		" 19	...	291	58
" 30	...	293	45		" 29	...	290	59

On October 4 the distance will still be 59′, but after that date it will slowly decrease, until on November 13 it will be only 18′.

According to a note communicated by Prof. Perrine to the Astronomical Society of the Pacific, and reproduced in No. 4035 of the *Astronomische Nachrichten*, Dr. Ross has also computed the orbit of Jupiter's sixth satellite. This satellite, like the seventh, moves in a direct orbit, its period being 242 days. The eccentricity of the orbit is large, amounting to 0·16, and the inclination to the plane of Jupiter's equator is about 30°. The mean distance of the satellite from Jupiter is about seven million miles. Thus the periods, and therefore the distances from Jupiter, of the sixth and seventh satellites are nearly alike, their orbits mutually interlocking. Otherwise the two orbits are dissimilar.

THE FORMATION OF THE NEW NORTH POLAR CAP ON MARS.—According to Mr. Lowell's observations, as recorded in No. 22 of the *Lowell Observatory Bulletins*, the first frost of this year in the Arctic regions of Mars occurred on May 19. The region wherein the phenomena were observed had been under daily scrutiny since coming into view on May 11, but no new feature had been discovered. However, on May 19 an enormous, unmistakably white patch was seen which extended from the western edge of the old cap to a point on the terminator about one and a half times the old cap's diameter away, and reached down to latitude +63°. The deposit was so thin on its northern edge that the band girdling the old cap could be plainly seen showing through it, but on May 20 a bright nucleus formed on the southern edge of the frost-bound area.

The date of the first observation corresponds to August 20 in our calendar, and is 126 days after the summer solstice in the northern hemisphere of Mars. In 1903 the first frost effects were observed on Mars about 128 days after the summer solstice; thus the recent observation strongly confirms those made in 1903.

LIQUID AIR—PRODUCTION AND APPLICATIONS.[1]

IN the former of these papers the author details experiments showing the trustworthiness of a German silver platinum couple to measure temperatures in the neighbourhood of those of liquid air and liquid and solid hydrogen. The electric resistance of metals is an unsafe guide at very low temperatures, and the manipulation of gas thermometers involves much time and care. A thermo-electric junction would be much more convenient if trustworthy. That it is trustworthy the experiments go to show, but only within limits. If the constants of the formula for interpreting the observations be determined at temperatures between 90½° and 123½° abs., the formula will then give the temperature of solid hydrogen at low pressure as 15°·27 abs., whereas if the constants be deduced from experiments at a lower temperature, 20½° to 77½°, the interpretation formula then makes the temperature of solid hydrogen at low pressure 1¾° lower, *i.e.* 13°·5 abs., which the author considers more correct. Bearing in mind that at this very low temperature a difference of 1¾° is equivalent to a difference of 37° at the ordinary temperature, we see that the method has no confirmatory value, and can itself be trusted only over the range for which it has been verified by the careful use of gas thermometers. If, therefore, helium be procured in sufficient quantity for liquefaction or solidification, its lower temperatures, possibly within 5° of the absolute zero, will have to be ascertained by the low-pressure helium thermometer. For ranges of temperature over which its indications can be verified, the thermoelectric junction thermometer will have a useful sphere of work in saving the inconvenience of employing gas thermometers. Among important cautions given by the author is a warning that junctions made with soft solder are affected by the low temperature. The junctions should be made with hard silver solder, and the indications at the temperature

[1] "On the Thermo-electric Junction as a Means of Determining the Lowest Temperatures, and on Liquid Hydrogen and Air Calorimeters." Papers by Sir James Dewar, read before the Royal Society, June 8, 1905.

of liquid oxygen compared before and after exposure to the temperature of liquid hydrogen, to see whether there has been any change produced. A German silver platinum junction was employed, but as the result of his experience the author recommends German silver gold.

The paper on "Liquid Hydrogen and Air Calorimeters" gives an account of experiments in which the specific heats of substances are determined by measuring the quantity of liquid air or hydrogen which they vaporise in falling through a given range of temperatures. From these experiments it appears that, at temperatures between those of these two liquids, ice has only one-third of its specific heat at ordinary temperature, graphite has only one-tenth, while diamond has as little as one-nineteenth of its ordinary specific heat. The second part of this paper deals with the latent heats of the volatile liquids, that of hydrogen being given as 121 or 122 calories, of oxygen 51·15 calories, and of nitrogen 50·4 calories. The latent heat of liquid air is not yet definitely determined, but when there is a high percentage of oxygen it is about 54 calories. The specific heat of hydrogen is found to be substantially the same, whether the substance be liquid, occluded, or gaseous.

The employment, just mentioned, of liquid air to determine the specific heat of substances may be called a practical application, though, so far, its utility is limited to scientific research; and the present time, ten years after the introduction of the new and comparatively economical method of producing it, is suitable for a review of its applications generally, the further developments in the methods of producing it, and the extent to which it has been possible so far to realise the expectations founded on the appearance of the new method of production.

It will be remembered that down to the year 1895 the method of liquefying air developed and employed by Olszewski and Dewar was what is called the cascade method, in which a gas condensed at high pressure is vaporised at a much lower pressure, so as to produce a much lower temperature, one low enough, perhaps, to condense a more volatile gas highly compressed. Thus nitrous oxide was made to produce liquid ethylene at a temperature below −90° C., and the ethylene, boiled at low pressure, similarly produced liquid oxygen, nitrogen, or air at −140° C. These liquids, boiling in the open, reduced their residual portions to their well known boiling points, and, boiled at low pressure, produced much lower temperatures, but in no case low enough to act in the same way as a means of liquefying compressed hydrogen, which is so volatile that its critical temperature is below the lowest obtainable by boiling the atmospheric gases at low pressure. The nearest approach to the liquefaction of hydrogen was Olszewski's imitation of Cailletet's combination of the cascade system with sudden expansion. He obtained a similar result—the brief appearance of an evanescent mist, which just sufficed to show that hydrogen was, under proper conditions, liquefiable. An ingenious means for getting below the lowest temperatures obtainable on the cascade system by boiling oxygen or nitrogen at low pressure was adopted by Olszewski and Dewar, who mixed hydrogen, the former with oxygen, the latter with nitrogen, in the hope of making a substitute for a natural gas of intermediate properties, which, boiling at low pressure, would give a temperature low enough for the liquefaction of compressed hydrogen on the cascade system. Both attempts were unsuccessful, though Dewar thought that the nitrogen jelly behaved as if it had some condensed hydrogen in solution.

At this stage there appeared a new and more powerful method for cooling and liquefying gases, the self-intensive system, by which compressed gas, allowed to cool itself by expanding to low pressure at a free orifice, has its cooling accumulated by an interchanger, and so intensified continually. Thus oxygen, nitrogen, and air starting from ordinary temperatures, and hydrogen starting from a temperature below −200° C., can be made to cool themselves to the liquefaction point, and gradually liquefy themselves at ordinary pressure without the help of any less volatile liquid to assist the fall of temperature.

With such apparatus available, great expectations were indulged in as to the future possibilities of liquid air. As with electricity, the enthusiast and the impostor were soon at work, making unlimited promises to attract the interest of the public, and company schemes to attract their money. Liquid air as a source of power was going to eclipse and replace steam and electricity. As an artificial refrigerant it was to banish ice, ammonia, sulphur dioxide, and carbonic acid. In surgery it was soon to be the only anæsthetic, antiseptic, and caustic employed; in medicine it was to cure consumption and many other diseases. Our prominent scientific men cannot claim much credit for doing their duty to the public in this matter. In a few reported interviews some of them mildly recommended caution. In this country only one prominent worker with liquid air plainly warned the public at the beginning of this boom that such promises were either foolish or fraudulent, and declared that on the score of expense liquid air, as made by the new method, could never compete with steam as a source of power or with ice as a source of refrigeration. The last ten years have too fully justified the warning; but in the meantime large sums of money were extracted from the public in America by fraudulent liquid air companies, one of which attempted to continue operations in this country; and many business men in England held over orders for new refrigerating plants for some years, for fear lest, as soon as they had put one down, they might find it superseded by a liquid-air contrivance. Apart from scientific research, the nearest approach to a commercial application of liquid air began last autumn, when experiments were given at music-halls under the name of the "Magic Kettle." The performance was anything but a popularising of scientific knowledge, of which the performers themselves in most cases had none; besides which they purposely deepened the mystery of the matter by adding a little juggling, and making misleading statements.

Air liquefiers of the best make are now such perfect machines that they seem to offer no scope for improvement within the existing system. The chief attempt to improve the system consists in substituting an engine to do work for the free-expansion valve, in order to obtain more cooling for a given amount of compression. This device, in the form of a turbine, was discussed as early as 1895, but rejected on the ground of complication. In 1896 Lord Rayleigh suggested it in a letter to NATURE, and others have proposed or attempted it since. Thermodynamically it would be a great gain; but in apparatus of this kind a thermodynamic gain often actually involves a greater practical loss, owing to the importance of simplicity. In *Comptes rendus*, vol. cxxxiv. pp. 1568–1571, is an account of such an apparatus made by M. G. Claude, which is declared to have been entirely successful. As this is purely a question of economy and convenience, which are dominating factors commercially, the fact that this apparatus is not yet displacing others makes it likely that the complications involved are found to be a serious stumbling-block. They have hitherto prevented the adoption of a similar device in commercial refrigerating machines working with ammonia and carbonic acid, which are now made on such a very large scale that in them, if anywhere, the thermodynamic gain would outweigh the complications.

One of the most promising practical applications proposed for liquid air has been the manufacture of oxygen from air by liquefying it and letting the nitrogen boil away before the oxygen, separating them by distillation. Theoretically the power, that is, the cost, required should be small. The latent heat taken up by the two gases separately in volatilising should balance that given out by the air in condensing. One of the prominent names associated with attempts of this kind is that of Pictet, who was long believed to have liquefied oxygen and hydrogen at the time when Cailletet undoubtedly produced a mist of oxygen. In New York Pictet was associated with others in an attempt of this kind under a patent (U.S.A.) in which he commits the fallacy of expecting the gases to separate at a low temperature, but while both are still in the gaseous condition, the greater density of the oxygen taking it to the bottom of the container! The oxygen did not drop, but the scheme, the patent, the fallacy, and the investors' money did. Pictet next appeared with a French patent, in which the U.S. patent fallacy was replaced by another. He arranged to make

a gain of cooling by letting liquid air vaporise at a lower temperature than that at which it had condensed, taking up more latent heat at the lower temperature than it had given out at the higher; and he overlooked the fact that the difference would be balanced by the specific heat given out by the liquid while being cooled to the lower temperature! Under a fresh patent in England Pictet has now for some years been associated with powerful supporters in installing a large and costly plant at Manchester with the same object. None of the former fallacies appear in the new patent. Whether practical success will attend the effort remains to be seen.

The liquid oxygen, or air rich in oxygen, obtained by distillation from liquid air, if mixed with a good combustible, such as cotton wool, makes an explosive. The Austrian military authorities, and the engineers engaged in tunnelling under the Alps, both made long and careful trials of such explosives; but the inevitable arrangements were too cumbrous, and the results too uncertain.

The nearest attempt to make what is called a practical use of liquid air is that of Dr. Allan Macfadyen (see NATURE, June 18, 1903, p. 152, and October 22, 1903, p. 608). By freezing the bacilli of typhoid in liquid air he makes them brittle enough for trituration in a mortar. By centrifugalisation the intracellular poison can then be separated from more fibrous material, and then by the methods of Pasteur an anti-typhoid serum prepared which promises to be of real value.

The most pronounced successes of liquid air have been in connection with scientific research. It was with liquid air made by the self-intensive process with a Hampson machine that Sir William Ramsay discovered krypton, xenon, and neon, that Prof. Rutherford and Mr. Soddy proved the emanations of radium and thorium to be condensable and vaporisable, that Ramsay proved the evolution of helium from radium emanations, and many other important investigations were carried out. Finally, it was by an extension of the same process that hydrogen was liquefied.

THE MEETING OF THE BRITISH MEDICAL ASSOCIATION.

A NUMBER of valuable and instructive papers were contributed at the recent meeting of the British Medical Association at Leicester, but the majority were technical and of a medical nature. The following, in addition to those described last week (p. 330), are, however, of more general interest:—

In the section of medicine, Dr. Nathan Raw (Liverpool) read a paper on human and bovine tuberculosis, with special reference to bovine infection in children. He said that while agreeing with the German view that there were decided differences between the bovine and human tubercle bacilli, he believed that bovine tuberculosis was a danger to human beings.

Bovine tuberculosis affected young people, was traceable to infected milk, and infected the tonsils, the alimentary tract, the glands, and, through the blood, the meninges, the bones, the joints, and other parts, while human tuberculosis was air-borne, and infected adults by way of the lungs as pulmonary phthisis. In evidence of this Dr. Raw indicated the rarity of pulmonary phthisis in infants and children, and, on the other hand, the comparative rarity of other than pulmonary lesions in adults, and suggested, further, that early tuberculous disease, presumably bovine, appeared to be protective against phthisis, as the development of pulmonary tubercle was relatively rare in those of a strumous diathesis who had suffered in infancy from bone and gland lesions.

In conclusion, Dr. Raw alluded to the frequency of tuberculosis among cattle, and the importance of the inspection of cattle and dairies.

Dr. F. J. Poynton (London) gave the results of his experience of milk to which sodium citrate had been added in the feeding of infants. The addition of sodium citrate to milk results in the formation of calcium citrate, and milk so treated forms a much finer curd and is more digestible than untreated milk. The sodium citrate may be added to the amount of 1 to 2 grains to the fluid ounce of milk.

In the section of ophthalmology, Prof. Hess (Würzburg) demonstrated by a series of beautiful drawings the influence of light in causing a migration of pigment in the retina of cephalopods. He had found in these eyes visual purple which had hitherto not been detected in any invertebrate.

All cephalopods studied by him showed this pigmentary migration within the retina, but the rapidity of the migration differed in various species, and it was different in different parts of the same retina, especially in the small horizontal stripe which contained very long and small rods, and corresponded evidently to an area of maximum vision.

In the section of tropical medicine, Mr. R. Newstead, of the Liverpool School of Tropical Medicine, read a paper on ticks concerned in the dissemination of disease in man, and gave a description of the *Ornithodorus moubata* which conveys tick fever, a spirillar infection, in the Congo Free State.

Mr. Newstead had found that in many respects the habits of the *Ornithodorus moubata* were not unlike those of *Argas persicus*, but the inert character of the larva of *Ornithodorus moubata* was unique among the Ixodinæ, in that it passes the whole of its life within the egg. The female *Ornithodorus moubata* laid eggs which were hatched, not as larvæ, but as nymphæ, although on the ninth day the larva was fully formed and the egg shell split, but the young tick remained until the fifteenth day, when as a nymph it escaped simultaneously from its larva covering and egg shell.

Dr. Graham (Sierra Leone) contributed a paper on guinea worm and its hosts. He had found that the incidence of the disease corresponded with the incidence of a cyclops, the presumed intermediate host, both seasonally and as regards its maximum manifestation.

SOME ASPECTS OF MODERN WEATHER FORECASTING.[1]

AFTER referring to the circumstances in which he was called upon to deliver the evening discourse in the absence of the Dean of Westminster, the lecturer explained that he had chosen the subject, not because he regarded weather forecasting as the only, or, from the scientific point of view, the most important practical branch of meteorology, but because, in a general sense, the possibility of its application to forecasting—the deduction of effects from given causes—was the touchstone of scientific knowledge.

The process of modern forecasting was illustrated by the daily weather charts of the period from February 1, 1904, up to the evening of February 12, which exhibited the passage over the British Isles of a remarkable sequence of cyclonic depressions, reaching a climax in a very deep and stormy one on the evening of the lecture. It was thus pointed out that the barometric distribution and its changes were the key to the situation as regards the weather, and this was supported by exhibiting the sequence of weather accompanying recognised types of barometric changes, as shown in the self-recording instruments at the observatories in connection with the Meteorological Office.

Some cases of difficulty in the quantitative association of rainfall or temperature changes with barometric variations were then illustrated. The barometric distributions in the weather maps for April 8 and April 16, 1903, were shown to be almost identical, and yet the weather on the later date was 10° colder than on the earlier. The observatory records for June 22, 1900, showed that a barometric disturbance of about the fiftieth of an inch, too small to be noticed on the scale of the daily charts, passed across the country from Valencia to Kew, over Falmouth, in about twenty-four hours, and produced at each observatory characteristic changes of temperature and wind, and also in each case about a fifth of an inch of rainfall.

Some examples of the irregularity of motion of the centres of depressions were also given, including one which travelled up the western coasts of the British Isles on October 14 and 15, and down the eastern coasts on

[1] Abstract of a discourse delivered at the Royal Institution of Great Britain by Dr W. N. Shaw, F.R.S.

October 16 and 17, 1903, one which developed from scarcely visible indications into a gale on December 30, 1900, and one which disappeared, or "filled up," as it is technically called, on February 6, 1904. The conclusion was drawn that the suggested extension of the area of observation by means of wireless telegraphy from ships crossing the Atlantic would not immediately place forecasting in the position of an exact science, but would add greatly to the facilities for studying the life-history of depressions.

The irregularities and uncertainties illustrated by the examples given might be attributed in part to the complexities of pressure due to the irregular distribution of land and sea in the northern hemisphere. Charts of the mean isobars for the world for January and July showed greater simplicity of arrangement in the southern hemisphere, where the ocean was almost uninterrupted, than in the northern hemisphere, where there were alternately large areas of sea and land. The comparative simplicity of the south as compared with the north was also illustrated by a chart representing an attempt at a synoptic barometric chart for the world for September 21, 1901.

The simplification of the barometric distribution at successively higher layers of the atmosphere, as illustrated by Teisserenc de Bort's chart of mean isobars at the 4000-metre level, was pointed out, and illustrations were also given of the method of computing the barometric distribution at high levels from observations at the surface, using data obtained from observations at high-level observatories, or those made with balloons and kites.

Some indication of the connection between the complexity of the surface and the simplicity of the upper strata might be established by means of careful observations of the actual course of air upon the surface and the accompanying weather conditions.

The actual course of air along the surface was often misunderstood. The conventional S-shaped curves representing the stream lines from anticyclonic to cyclonic regions were shown to be quite incorrect as a representation of the actual paths of air along the surface. A diagram contributed to the *Quarterly Journal of the Royal Meteorological Society*[1] showed the computed paths for special case of a storm of circular isobars and uniform winds, travelling without change of type at a speed equal to that of its winds. An instrument made by the Cambridge Scientific Instrument Company to draw the actual paths of air for a number of different assumptions as to relative speed of wind and centre, and of incurvature of wind from isobars, was also shown, and the general character of the differences of path exhibited under different conditions was discussed.

In illustration of the application of these considerations to practical meteorology, it was noted that rainfall is an indication of the existence of rising air, and conversely the disappearance of cloud may be an indication of descending air. It was further noted that if the ascent and descent of air extended from or to the surface, the actual paths of air along the surface, as traced from the direction and speed of the winds, ought to show convergence in the case of rising air and divergence in the case of descending air.

The chart for April 16, 1903, was referred to for an obvious case of dilatation or divergence of air from a centre corresponding with fine weather, the centre of the area of divergence being specially marked "no rain," and the actual trajectories or paths of air for two different travelling storms were contrasted, to show how the rainfall might be related to the convergence of the paths of air. The two occasions selected were (1) the rapid travelling storm of March 24–25, 1902, and (2) the slow travelling storm of November 11–13, 1901.[2] The trajectories or actual paths of air for these two storms had been constructed from two-hourly maps drawn for the purpose from a collection of records of self-recording barographs, &c. Those for March 24–25 showed the paths to be looped curves with very little convergence, whereas those for the storm of November 11–13 showed very great convergence; so much so that if four puffs of smoke could be imagined starting at the same time from Aberdeen, Blacksod Point, Brest, and Yarmouth respectively, and travelling for twenty-four hours, they would find themselves at the end of the time enclosing a very small area in the neighbourhood of London.

Corresponding to this difference of convergence as shown by the paths was the difference of rainfall as illustrated by two maps showing the distribution of the rain deposited from the two storms. The first, with little convergence, gave hardly anywhere more than half an inch; the second, with its great convergence, gave four inches of rain in some parts of its area.

[1] The Meteorological Aspects of the Storm of February 26–27, 1903. *Q. J. R. Met. Soc.*, vol. xxix. p. 233, 1903.

[2] See Pilot Charts for the North Atlantic and Mediterranean, issued by the Meteorological Office. February, 1904.

BREATHING, IN LIVING BEINGS.[1]

IT has been said that the most striking facts connected with respiration are its universality and its continuity. In popular language "the breath is the life." Breathing is not only a sign of life, it is a condition of its existence. Permanent cessation of breathing is regarded as a sign of death. Link up with this the icy coldness of death and you have two significant facts.

Respiration and calorification are therefore intimately related; in fact, calorification is one form of expression of the results of respiratory activity.

The popular view of respiration is an inference from what is observed in man and animals. During life the rise and fall of the chest goes on rhythmically from the beginning to the end. The respiratory exchanges effected in the breathing organs—lungs or gills—constitute "external respiration." This, however, scarcely touches the main problem, viz. what is called "internal respiration," or tissue respiration—*i.e.* the actual breathing by the living cells and tissues which make up a complex organism.

We are told that man does not live by bread alone. We know he requires, in addition, solids, fluids and air. Taking these to represent the three graces, then air is of all the graces best.

The higher animals have practically no reserve stores of air—unlike what happens with the storage of fats and proteids—and hence the necessity for mechanisms by which air is continually supplied to the living tissues, and also by which the waste product of combustion, viz. carbon dioxide, is got rid of. Closure of the wind-pipe, even for a few minutes, brings death with it from suffocation. The entrance of oxygen is prevented and the escape of carbon dioxide is arrested.

The process of breathing is common to all living beings—to plants and animals alike. It consists essentially in the consumption of oxygen by the tissues and the giving out of carbon dioxide. It is immaterial whether the animals or plants live in water or air, the principle is the same in both cases. Living active protoplasm demands a supply of oxygen.

All the world's a stage. The human body is at once a stage, and a tabernacle—a vast theatre—and the myriads of diverse cells of which it is composed, the players.

The cells or players, as active living entities, not only require food, but they require energy. The respiratory exchanges in and by the living cells provide the energy for the organism. This breathing by the cells is called "internal respiration." In a complex organism, therefore, the respiratory exchanges represent the algebraic sum of the respiratory activity of the several tissues that make up the organism. The various tissues, however, breathe at very unequal rates.

In one of his charming "contes philosophiques," Voltaire describes the visit of a giant of Sirius to our planet. Before reaching his journey's end he would have to traverse an aërial medium, and on arriving would see before him a fluid medium in continual movement, and tracts of solid land. After investigation—or no doubt he would be told, even though he was not personally conducted—that the water surface of this our globe is two

[1] Abstract of a discourse delivered at the Royal Institution of Great Britain by Dr. William Stirling.

and a half times greater than the land surface. He would discover that there are animals that live in air, others in water, and again others on land. Our visitor would find out that the respirable media are two—water and air—and that there are 210 parts of free oxygen in a litre of air, while there are only 3–10 dissolved in a litre of water.

Had Voltaire's friend paid us another visit during the present century, we should be able to tell him that the water of the Thames above London contains 7·40 c.c. of O per litre; at Woolwich only 0·25; the decrease being due to the pollution of the river. Putting it broadly, water contains only 3–10 parts per litre, while air contains 210. Water-breathers under good conditions have twenty times less O than air-breathers. It is as if air-breathers on land had the percentage of O_2 reduced to 1.

He would also be told that carbon dioxide—CO_2—is also remarkably soluble in water, and readily combines with certain bases present in water; thus water forms an admirable medium into which an animal may discharge its effete and poisonous irrespirable CO_2.

He would also be told that our blood contains 60 volumes per cent. of gases, and that there is more O and less CO_2 in arterial blood than in venous blood.

Perhaps the name of Sir H. Davy might be whispered to him, for he was one of the first to detect the presence of gases O and CO_2 in blood.

In story, one has heard of the "Quest of the Holy Grail." I have even listened with rapt attention to an entrancing lecture on the "Quest of the Ideal." For the cell, the quest is the "quest of oxygen," and it is not happy until it gets it.

We speak of a distinction between air-breathers and water-breathers. If, however, we push the matter to its ultimate issue, we find that all our tissues—and equally those of plants—live in a watery medium; in us the fluid lymph which exudes from our capillary blood-vessels, and in plants in the sap. Thus we come upon what at first seems a paradox, but is not so; all our cells not only live in water, but they live in running water. They are bathed everywhere by the lymph which is the real nutrient fluid for our cells. Thus, in its final form, all respiration is actually aquatic. The process of internal respiration, besides other conditions, requires the presence of a certain amount of water. In fact, all vital phenomena require the presence of water.

The unity and identity of the process in animal and vegetable cells, as the theatre of combustion, is the striking fact. The means by which the necessary oxygen is brought to the cells is as varied as the forms of animated organisms themselves. This function exists for the cells, and not the cells for the function.

If the mountain will not go to Mohammed, Mohammed must go to the mountain. There are, at least, two principles on which animal cells obtain oxygen.

The air or water containing air is carried to the cells. This is the principle adopted in the lower invertebrates, as in sponges and with regard to certain air-breathers such as insects.

The other principle is this, that an intermediary carries the respiratory oxygen from some more or less central localised or diffuse surface to the cells. This intermediary is the blood—an internal medium of exchange. The fluid part of the blood may carry the oxygen supply and remove the carbonic dioxide waste. This is the case in many of the invertebrates, and it reaches its highest development in the vertebrates. Hence in them the circulating and respiratory systems reach their fullest development.

In most invertebrates the fluid part of the blood contains the nutritive substances and also the oxygen and carbonic acid. In the vertebrates, the hæmoglobin of the red blood corpuscles carries the oxygen from the gills or lungs to the tissues, whilst the CO_2 is contained in and carried chiefly by the blood plasma from the tissues to the gills or lungs.

It is singular that in the cephalopods, such as the squid and cuttle-fish, the blood is bluish in tint; and this is due to the presence in the plasma of a respiratory pigment called hæmocyanin. This body has a composition like that of hæmoglobin, but copper is substituted for the iron of the hæmoglobin. Copper also exists in organic combination in the red part of the feathers of the plantain-eater or turaco.

The real aristocracy with genuine blue blood are the crab, lobsters, squids, and cuttle-fishes.

Perhaps one of the most striking ways of dissociating this accessory mechanism from the activity of the cell itself is by the use of a poison. When a person is poisoned by coal gas, what happens? The coal gas contains carbon monoxide. This gas does not poison invertebrate animals or plants. Still it kills vertebrate animals. Why? It does not kill by acting on the living cells, only by depriving them of oxygen and asphyxiating them. It combines with the respiratory pigment hæmoglobin. Chloroform, ether, and similar drugs destroy the actual life of the cell elements by destroying their irritability.

In 1771, Priestley found that air vitiated by combustion of a candle, or by the breathing of animals—such as mice—could be made pure or respirable again by the action of green plants.

Under certain conditions, however, Priestley found that plants gave off carbonic acid, and the air did not support combustion or animal life. He regarded these as "bad experiments," and he selected what he was pleased to regard as "good experiments," *i.e.* those in which the air, rendered impure by the respiration of animals, was rendered respirable by the action of green plants.

In 1779 John Ingen-Housz published his "Experiments on Vegetables, discovering their great power of purifying the common air in sunshine, and of injuring it in the shade and at night."

He confirmed Priestley's observations that green plants thrive in putrid air, and that vegetables could convert air fouled by burning of a candle, and restore it again to its former purity and fitness for supporting flame, and for the respiration of animals—or, as he puts it, "plants correct bad air."

In 1787 Ingen-Housz, an English physician at the Austrian court, found that only in daylight did green plants give off oxygen. In darkness, or where there was little light, they behaved like animals so far as exchange of gases is concerned, *i.e.* they used up oxygen and exhaled carbonic acid. He found also that all roots, when left out of the ground, yielded by day and by night foul air, *i.e.* carbonic acid.

In the same year, 1804—the year of Priestley's death—Nicolas Theodore de Saussure, a Swiss naturalist and chemist, published his "Recherches Chimiques sur la Végétation" (Paris, 1804), a veritable encyclopædia of experiments of the effects of air on flowers, fruits, plants, and vegetation generally, and on the effects of these on atmospheric acid.

It is an old adage—the exception proves the rule. The exception "probes" the rule as the surgeon's probe probes a wound. The tactus eruditus of the surgeon, by his probe—indeed an elongated tactile sense—enables him to discover the presence or absence of a body in a wound. Had Priestley used the probe of a bad experiment, he in all probability would have anticipated the discovery of Ingen-Housz.

Some of you, no doubt, recollect the words of Goldsmith's famous description of his own bedroom and of the furniture of the inn—

> "The house where nut-brown draughts inspired."

And how his imagination stooped to trace the story of—

> "The chest that contrived a double debt to pay,
> A bed by night, a chest of drawers by day."

As to himself he tells us how—

> "A night-cap decked his brows instead of bay,
> A cap by night—a stocking all the day."

Green plants contrive a double debt to pay; they give off oxygen by day, and at night exhale CO_2.

How do the vast number of plants, the microbes, the bacteria without chlorophyll get oxygen? Most of them get it as we get it. Some, however, cannot live in pure oxygen and are anærobic, such as the micro-organisms that cause tetanus, malignant œdema, and those that set up butyric acid fermentation.

Pushing the matter still further, it is extremely probable that the oxidation processes in our tissues are largely due to the presence of oxydases.

This raises the question as to the part played by the nucleus of a cell in its respiratory processes.

Is the source of muscular energy to be sought in oxidation or cleavage processes in tissues? In some animals there is not a direct relation between the muscular work and oxygen consumed, though there is to heat production. Bunge, on this ground, thought that the intestinal parasites of warm-blooded animals must have their oxygen at a minimum. In the intestinal contents there is no estimable oxygen; there active reduction processes go on. Entozoa might get oxygen from O_2 diffusing from blood-vessels.

Bunge found that intestinal worms of the cat and pike can live in an alkaline solution of common salt, free from gases, under Hg, for four to six days. They made active movements, and gave off much CO_2.

Ascaris lumbricoides from the intestine of the pig lived four to six days in 1 per cent. boiled NaCl solution. It made little difference whether oxygen or hydrogen was passed through the fluid. They lived seven to nine days if fluid was saturated with carbon dioxide, so that they have accommodated themselves to high percentages of carbon dioxide.

They give off to the fluid valerianic acid, an acid with a characteristic butyric acid odour. These worms contain a very large quantity of glycogen, the dry body yielding 20 per cent. to 34 per cent. of this carbohydrate.

100 grams Ascaris, placed in boiled normal saline solution, used per day—

0·7 gram glycogen,
0·1 „ sugar,
No fat;

and yielded—

0·4 gram CO_2
0·3 valerianic acid.

It would seem that glycogen had split into CO_2, and valerianic acid—

$$4C_6H_{12}O_6 = 9CO_2 + 3C_5H_{10}O_2 + 9H_2$$
$$720 = 396 + 306 + 18.$$

Is it a genuine fermentation?

Weinland found that he could express by Buchner's method a substance, "zymase," which could split glycogen into CO_2 and valerianic acid.

Turning now to respiration in invertebrate animals, and dealing first with those which live in water, let us see some of the contrivances by which this end is achieved. The mechanisms are but means to an end. The ultimate union of oxygen, and the discharge of carbon dioxide with the liberation of energy, occur in the protoplasm of the cell itself.

There are two distinct processes, and it may be that the oxygen is introduced by one portal and the carbon dioxide got rid of by another, or it may be that one portal may do for both processes—the letting in of oxygen and the giving off of carbon dioxide.

Although the principle itself is simple, the variety of mechanisms adopted by nature to secure this double function is remarkable. Let us glance at some of the mechanisms proceeding from the simple to the complex, and first with regard to those animals that live in water.

Consider the oceanic fauna. It is immense both from the point of view of number and variety. Save insects and certain groups of molluscs, all invertebrates are aquatic. Amongst vertebrates, fishes have aquatic respiration, and some mammals, *e.g.* cetaceans or whales, have water as their sphere of existence, though they depend on the air for their respiratory oxygen.

The evolution from an aquatic to an aërial mode of existence can be traced in the animal kingdom, and may even be seen within limits in the history of certain species.

Every living cell, animal or vegetable, requires for its continued existence a supply of oxygen, and every living cell exhales carbon dioxide. The exchange of these two gases between the fluids of the body and the outer medium is the process of respiration. The simplest form of respiratory exchange occurs where there is no specially differentiated organ or mechanism for this purpose, so-called diffuse respiration. The whole surface of the organism in a watery medium may be concerned in this respiratory exchange. This is only possible, however, so long as the boundary surface, skin, or otherwise is permeable to gases, and no great respiratory exchanges are necessary.

Before showing you some lantern slides, I should like to point out how one process is made to aid another.

Motion associated with respiratory processes.

Ciliary motion with respiration and the capture of prey for food.

The old idea of one function for an organ is exploded. One speaks of one man one vote. One man one value. It is not really so.

With Shelley we may say—

"Nothing in this world is single;
All things, by a law Divine,
In each other's being mingle."

As regards the surfaces for these respiratory exchanges for diffuse respiration, it may take place through the inner surface of the body cavity of cœlenterates, the under surface of the bell of a medusa, the tentacles of an echinus, the respiratory tree at the hind gut of the sea cucumber, or the intestine of the young of the dragon fly, or by the intestinal mucous membrane of the mites which have no lungs or other directly respiratory organ. In the higher animals we have tracheæ, gills and lungs.

In some animals, the respiratory mechanism is closely related to the motor apparatus, as in some crustacea. In some mollusca the nutritive and respiratory mechanisms are closely related. In the highest of all there is central apparatus—gills or lungs—for the respiratory exchange between the blood and the air, and a circulatory apparatus for carrying the blood to and from the respiratory organs. The adaptivity of insects to varied conditions of oxygen supply is marvellous.

Before showing some classical experiments and illustrating the principles already laid down, I should like again to direct your attention to the association of several processes with respiratory mechanisms.

[The lecture was illustrated by means of lantern slides, showing the respiratory mechanisms from the lowest to the highest animals, and also by a number of experiments dealing with the chemical exchanges in the process of respiration. Lastly, the classical experiment of John Hunter, on the pneumaticity of the bones of birds, was shown in the duck. A candle flame was extinguished when held in front of the divided trachea, when air was blown into the divided humerus bone of the wing.]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ON June 27, Amherst College, Massachusetts, conferred the degree of M.A. upon Mr. Lundin, of Messrs. Alvan Clark and Sons, the following being President Harris's characterisation:—"CARL AXEL ROPERT LUNDIN: Scientific expert in cutting and fashioning glasses of great telescopes. He has done important work on the large objectives of Russia, of the Lick and Yerkes observatories, and lately on the 18-inch objective of the Amherst College Observatory, which is wholly his work. In 1854 Amherst conferred the degree of Master of Arts on Alvan Clark, who had built our first telescope. The same degree, for a similar service, is conferred on his successor, who has kept pace with the progress of astronomical science."

AN interesting inquiry as to the representation of science in the principal public libraries of Paris is being made by the *Revue Scientifique*, and the results are published week by week, from July 1 onwards, in the form of letters and opinions from the principal librarians and professors of science in France. The opinion is generally expressed that an unsatisfactory state of affairs exists in libraries such, for instance, as the Bibliothèque nationale and the library of the University of Paris owing to the fact that the librarians are almost exclusively graduates in arts and letters, and ignorant of the requirements of men of science. It thus happens that, the available funds

being limited, preference is given in the purchase of foreign works to the departments of history, letters, and the arts, these being the subjects in which the librarians themselves have special interest and knowledge. Important scientific books are thus often overlooked. The current books of reference and the principal foreign journals are difficult of access, and are not at hand for immediate use; journals are often not available for a year, or more, after the date of issue owing to their being sent to the binders. For these reasons, and on account of the time wasted in waiting and formalities, the principal libraries are hardly used at all for scientific purposes by most of the workers engaged in active research. The professors and teachers of Paris consider that the special libraries attached to the actual laboratories are more valued and are of greater use than the larger and more general libraries, and that these should be coordinated so as to be available for any properly accredited worker. On the other hand, there seems to be a desire on the part of the Government to limit the usefulness of these actual working libraries by reducing the grants formerly allotted to them. Some of the criticisms of the Paris libraries and suggestions for their amelioration are not without application in this country.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 15.—"Contributions to the Physiology of Mammalian Reproduction. Part i., The Œstrous Cycle in the Dog. Part ii., The Ovary as an Organ of Internal Secretion." By F. H. A. **Marshall** and W. A. **Jolly.** Communicated by Prof. E. A. Schäfer, F.R.S.

The experiments lead to the conclusion that the ovary is an organ providing an internal secretion which is elaborated by the follicular epithelial cells or by the interstitial cells of the stroma. This secretion circulating in the blood induces menstruation and heat. After ovulation, which takes place during œstrus, the corpus luteum is formed, and this organ provides a further secretion the function of which is essential for the changes taking place during the attachment and development of the embryo in the first stages of pregnancy.

June 8.—"Researches on Explosives." Part iii. By Sir Andrew **Noble,** Bart., K.C.B., F.R.S.

The principal object of the researches which are communicated in this paper was to ascertain, with as much accuracy as possible, the differences in the transformations which modern explosives suffer when fired under gradually increasing pressures. The first part of the paper gives a description of the varied apparatus employed.

Although the author has made experiments with many other explosives, those examined in this paper are three in number:—(1) Cordite; (2) the cordite known as M.D.; and (3) a tubular nitro-cellulose.

The modes of observation and calculation followed are described, and then in tabular form are given the results of the series of experiments on the three explosives named. These tables being too extensive to reproduce in full, the results of the experiments at the lowest and highest densities alone are given:—

	Cordite Mark I.		M.D. Cordite		Nitro-Cellulose	
Density of charge exploded.	0·05	0·50	0·05	0·45	0·05	0·45
Volumes of permanent gas per gram.	678·0	623·6	781·8	676·3	814·7	680·9
Volume of total gas per gram.	877·8	798·8	955·4	810·6	993·1	816·3
Percentage volumes of permanent gases.						
CO_2 ...	27·15	41·95	18·15	36·60	17·90	35·00
CO ...	34·35	19·10	42·60	24 80	43·45	27·85
H ...	17·50	12·05	23·15	11·90	24·40	12·65
CH_4 ...	0·30	7·05	0·35	10·70	0·60	11·10
N ...	20·70	19·85	15·75	16 00	13·65	13·40
Percentage volumes of total gases.						
CO_2 ...	20·97	33·02	14·85	30·56	14·68	29·16
CO ...	26·53	15·03	34·87	20·71	35·63	23·20
H ..	13·52	9·48	18·95	9·94	20·01	10·54
CH_4 ...	0·23	5·55	0·29	8·94	0·49	9·25
N ...	15·99	15·62	12·89	13·36	11·19	11·16
H_2O ...	22·76	21·30	18·15	16 49	18·00	16·69
Percentage weights of total gases.						
CO_2 ...	36·10	51·84	27·69	48·75	28·19	47·26
CO ...	29·00	15·03	41·38	21·02	43·53	23·92
H ...	1·14	0·67	1·62	0 72	1·74	0·79
CH_4 ...	0·18	3·18	0·18	5·19	0·34	5·45
N ...	17·63	15·65	15·32	13 59	13·71	11·54
H_2O ...	15·95	13·63	13·81	10·73	12·49	11·04
Pressure in tons per square inch.	2·9	52·9	2·7	43·22	3·35	40·5
Pressure in atmospheres.	442·1	8063·8	411·6	6587·3	510·7	6173·6
Units of heat, water fluid.	1272·3	1360·0	1035·9	1190·0	896·1	1036·9
Units of heat, water gaseous.	1186·8	1287·0	961·9	1132·5	829·2	977·7
Specific heat.	0·23040	0·22385	0·23714	0·22529	0·23772	0·22828
Temperatures of explosion, Centigrade.	5151°·1	5749°·4	4056°·2	5026°·8	3488°·1	4282°·9
Comparative potential energy.	0·9825	1·0000	0·8401	0·8842	0·7389	0·7686

If the figures given in these tables be carefully examined, it will be observed that for the three explosives the transformation on firing appears, in all, to follow the same general laws.

Thus in all three there is, with increase of pressure, at first a slight increase, afterwards a steady decrease, in the volume of permanent gases produced.

In all three explosives there is, with increased pressure, a large increase in the volume of carbonic anhydride, and a large decrease in the volume of carbonic monoxide. In the volume of hydrogen this decrease with increase of pressure is very great; while methane, the percentage of which with low pressures is quite insignificant, very rapidly increases, and at the highest density is from twenty to thirty times greater than at the lowest density.

There are some variations in the percentages of nitrogen and water vapour, but on the whole these constituents may be considered to be nearly constant.

The units of heat developed show with increased pressure a slight decline at first, but afterwards increase somewhat rapidly at the higher pressures.

In the tables submitted it will be observed that the specific heats and the temperatures of explosion have been given, but with respect to temperatures so far above those in regard to which accurate observations have been made the figures given can only be taken as provisional.

These temperatures have been obtained by dividing the units of heat (water gaseous) by the specific heats; although provisional, they can safely be used in comparing the temperatures of explosion of the three explosives.

The comparative approximate potential energies are obtained by multiplying the volume of gas produced by the temperature of explosion. The means for the three explosives are respectively:—cordite, 0·9702; M.D., 0·8387; nitro-cellulose, 0·7464. The highest potential energy (taken as unity), it will be noted, was obtained from cordite at a density of 0·5.

It is submitted that the wide differences in the transformation of the three explosives with which the experiments have been made justify the general conclusion at which Sir F. Abel and the writer arrived in the year 1874 (*Transactions of the Royal Society*, vol. clxiii. p. 85) with respect to gunpowder, viz. that any attempt to define by a chemical equation the nature of the metamorphosis which

an explosive may be considered to undergo would only be calculated to convey an erroneous impression regarding the *definite nature* of the chemical results and *their uniformity* under different conditions.

The paper continues with a description of the experiments made to determine the time required for the complete ignition of certain explosives, and also of other experiments to determine the rate at which the exploded gases part with their heat to the walls of the vessels in which they are confined; and in conclusion it is pointed out that the experiments made on erosion, with the three explosives referred to in this paper, and with some other explosives, have satisfied the author that the amount of absolute erosion is governed practically entirely by the heat developed by the explosion.

"Colours in Metal Glasses, in Metallic Films, and in Metallic Solutions." II. By J. C. Maxwell **Garnett.**

Expressions, giving the refractive index and the absorption coefficient (the optical constants) of a compound medium consisting of metal (1) in small spheres (granular), and (2) in discrete molecules (amorphous), diffused through an isotropic non-dispersive transparent medium (the solvent), in terms of the corresponding optical constants of the normal metal, were first obtained. The particular formulæ, which apply when the volume proportion (μ) of metal in the compound medium is small, followed immediately. By means of these formulæ and of the numerical values of the optical constants of gold, silver, and copper for monochromatic light of several different wavelengths, the values of the corresponding optical constants of diffusions of spheres and of molecules of these metals, in glass, in water, and *in vacuo*, were calculated and tabulated. The absorptions of monochromatic light by specimens of gold and copper ruby glass and of silver-stained glass were measured. A comparison of the measured absorptions of gold ruby glass with the calculated absorptions of gold spheres and of gold molecules diffused in glass, and a collation of the results with others previously published,[1] show that the colour of gold ruby glass is primarily due to the presence of spheres (not molecules) of the metal. The presence of crystallites, formed by the coagulation of the gold spheres, and reflecting red light, accounts for the irregular blue and purple colours sometimes transmitted by gold glass. Further, when the absorptions of a colloidal solution of gold in water are compared with the calculated absorptions of gold spheres and molecules diffused in water, it appears that colloidal gold consists of small spheres in suspension.

The close similarity between the observed absorptions of glass stained (amber) with silver, and the calculated absorptions of silver spheres in glass—those of a diffusion of silver molecules in glass are quite different—indicates that the stained region must contain small spheres of silver. The presence of silver spheres (but not of discrete molecules of silver) also accounts for the brilliant blue reflection from the interface between the stained and unstained regions of Stokes's specimens of silver glass. Ehrenhaft's[2] description of the nature and position of the absorption band observed in the spectrum of colloidal solutions of silver describes so well the position of the absorption band determined by calculation for a diffusion of silver spheres (but not of silver molecules) in water as to justify the conclusion that the bulk of the silver present in colloidal solution is in the form of small spheres, little, if any, being in true solution (*i.e.* molecularly subdivided); and this conclusion is confirmed by the fact that the refractive index of a colloidal solution of silver, which was measured by Barus and Schneider, is precisely that which calculation gives as the refractive index of a diffusion of silver spheres (but not of molecules) in water.

A comparison of the observed and calculated absorptions shows that copper ruby glass owes its colour to the presence in the glass of small spheres of metallic copper; but some copper molecules are probably also present.

Calculation proves that diffused spheres of cobalt would give a reddish colour to glass. Cobalt glass is not coloured by the metal in the metallic form.

1 *Phil. Trans.*, A, 1904, pp. 385 *et seq.*; NATURE, vol. lxx. p. 213 (June 30, 1904).

2 Felix Ehrenhaft, *Ann. der Phys.*, vol. xi. p. 489 (1903).

The colours produced in gold, silver, and soda glasses by the radiation from the emanation from radium suggest that these glasses contain free ions of the metal, and that it is by the discharge of these ions and the consequent reduction of the metal that kathode and Becquerel rays are able to colour the glasses.

Curves were constructed to show how the calculated absorptions and reflections of red, yellow, green, and blue light by gold and silver films vary with the volume proportion, μ, of metal in the film; and a comparison of these calculated colour changes with those exhibited by the gold and silver films, which Faraday and Beilby had prepared, when subjected to heat and to pressure, indicated that (*a*) the films as first prepared were in the amorphous or granular phase; (*b*) heating diminished the density of the film, while pressure was able to increase that density again; and finally (*c*) this diminution of density was probably effected by the passage of the metal from the amorphous to the granular phase, and by the growth of the larger granules at the expense of the smaller, while increase of density was accomplished by changing some of the metal from the granular to the amorphous phase.

Optical and other evidence led to the conclusion that Carey Lea's silver was not allotropic, but consisted of normal silver in a finely divided (but not necessarily granular) state. It appeared, therefore, probable that many forms of metals, which have hitherto been supposed to be allotropic because they possessed optical properties distinct from those belonging to the metals in their normal states, were merely cases of fine division. Thus the properties of Bolley's lead, of Schützenberger's silver, and of other alleged cases of allotropy cited by Roberts-Austen ("Metallurgy," p. 90), do not require the postulation of an allotropic molecule for their explanation.

Faraday Society, July 3.—Mr. W. R. Cooper in the chair.—Some notes on the rapid electro-deposition of copper: Sherard **Cowper-Coles.** The various processes for increasing the current densities in copper deposition by using mechanical means for keeping the copper smooth are classified as follows:—(1) revolving or moving the kathode; (2) burnishing the copper during electrodeposition; (3) insulating the growths on the copper so as to prevent further increase; (4) rapid circulation of the electrolyte; (5) revolving mandrel at a critical speed (centrifugal process).—The use of balanced electrodes: W. W. Haldane **Gee.**—The electrolytic oxidation of hydrocarbons of the benzene series, part ii., ethyl benzene, cumene and cymene: H. D. **Law** and Dr. F. Mollwo **Perkin.**—The electrolytic analysis of antimony: H. D. **Law** and Dr. F. Mollwo **Perkin.**—Notes on heat insulation, particularly with regard to materials used in furnace construction: R. S. **Hutton** and J. R. **Beard.**—Storage batteries and their electrolytes: R. W. **Vicarey.**—Alternate current electrolysis: Prof. E. **Wilson.**—The two last papers were taken as read, and the discussions postponed until the autumn.

DUBLIN.

Royal Irish Academy, June 26.—Prof. R. Atkinson, president, in the chair.—Prof. Ronald **Ross** gave an account of the researches which resolved the malaria problem, and took occasion to refer to the interesting mathematical problems connected with the diffusion of mosquitoes.

PARIS.

Academy of Sciences, July 31.—M. H. Poincaré in the chair.—The study of refraction at all heights. Formulæ relating to the determination of the coordinates of the stars: M. **Lœwy.** A development of a system of formulæ allowing of the deduction of the positions of two pairs of stars according to the new method given in the *Comptes rendus* for July 17. Three tables of solutions accompany the paper.—On an endoglobular hæmatozoa found in the jerboa: M. **Laveran.** The parasite is described and classified as *Haemogregarina Balfouri.*—On a secondary reaction of the halogen organo-magnesium compounds: Paul **Sabatier** and A. **Mailhe.** The cause of the low yield sometimes observed in the reaction between a ketone

and an alkyl magnesium halogen compound is due to a secondary reaction resulting in the formation of a substituted ethylene. This tendency to the formation of an unsaturated hydrocarbon is especially marked in the case of the isobutyl derivatives. Details are given of several cases.—On the theory of surfaces and of envelopes of spheres in anallagmatic geometry: A. **Demoulin.**—On the properties of a holomorphic function in a circle where it does not take the values zero and unity: Pierre **Boutroux.** —On a new series of polynomials: A. **Buhl.**—On sliding friction: M. **de Sparre.** A solution of a problem enunciated by M. Appell in his treatise on mechanics. —The passage of electricity through gaseous layers of great thickness: E. **Bouty.** It has been shown in previous papers that the critical field $y=a\sqrt{p(p+b)}$, where p is the pressure (above 0·1 mm. of mercury), a the dielectric cohesion of the gas, and b a constant for the given flask and gas. In the present communication the constant b is found to be in inverse proportion with the thickness of the gaseous layer, e. The formula thus becomes

$$v=a\sqrt{p\left(p+\frac{k}{e}\right)},$$

where k is a constant which depends only on the nature of the gas.—The electrolytic detector with a metallic point: G. **Ferrié.** An experimental study of the use of the imperfect contact of a fine metallic point and an electrolyte as a detector for Hertzian oscillations.—On the phenomenon of Marjorana: A. **Cotton** and H. **Mouton.** A study of the behaviour of solutions of colloidal iron hydroxide in a strong magnetic field.—On a megaphone: G. **Laudet** and L. **Gaumont.** A gas flame, mechanically controlled, is used to intensify the sound waves.—On the state of matter in the neighbourhood of the critical point: Gabriel **Bertrand** and Jean **Lecarme.** Experiments made upon solutions of potassium bichromate in water and of alizarin in alcohol, at temperatures slightly above the critical points, have led to the conclusions that slightly above and below the critical temperature both the liquid and gaseous states exist simultaneously.—On the different states of oxidation of aluminium powder: M. **Kohn-Abrest.** Aluminium powder was heated by electrical means to various temperatures in a current of air; evidence was obtained of the formation of an oxide AlO.—The influence of the fragility of steel on the effects of mechanical treatment in a boiler works: Ch. **Frémont.**—The modification produced in the metal of rivets produced by the operation of riveting: M. **Charpy.**—On the constitution of sparteine: Charles **Moureu** and Amand **Valeur.** The authors summarise their recent work on this alkaloid, and propose a formula for it which is completely in accord with the facts known up to the present.—Chemical oxydases: G. **Baudran.**—On the variations of the basic function in chromium salts: Albert **Colson.**—On the presence of bile pigments in the medicinal leach: Camille **Spiess.**—Folded faults and horizontal overlapping in the Mesozoic of Portugal: P. **Choffat.**—On the geology of the southern Carpathians: G. M. **Murgoci.**—Observations on the mode of formation of deposits of blende enclosed in the stratified rocks: A. **Lodin.**

CALCUTTA.

Asiatic Society of Bengal, June 7.—Religion and customs of the Uraons or Oraons: Father **Dehon,** S.J., communicated by E. A. Gait. An account of the reputed origin, mythology, ceremonies, and folklore of an agricultural tribe now settled in Chota Nagpur, but thought to have come from farther south.—Note on a decomposition product of a peculiar variety of Bundelkhand Gneiss: C. **Silberrad.** A white clayey material found in the Ajaigarh State has been submitted by the author to Dr. O. T. Silberrad, the analysis of which is compared with that of pinite. The two substances were found to resemble one another.

July 5.—Four new barnacles from the neighbourhood of Java, with records of Indian pedunculate forms: Dr. N. **Annandale.** Of the new species, two belong to the genus Scalpellum, two to Alepas. Of the former, one is remarkable for its great size and for the reduction of the calcified valves; the other for its habit of forming a regular, branched, though not organically connected, colony of several generations. One Alepas is larger than any hitherto described. The specimens were presented to the Indian Museum by the Eastern Telegraph Company, and come, with one exception, from a depth of 160 fathoms. A list of the pedunculate cirripedes known from the seas of British India is added.—Additions to the collection of Oriental snakes in the Indian Museum, part ii.: Dr. N. **Annandale.** Notes on specimens lately received from the Andamans and Nicobars, with the description of a new sea-snake and a list of the Ophidia known to occur in these islands.—The Tibetan version of the Pramana-samuccaya, the first Indian work on logic proper, recovered from Tibet by the late Tibet Mission: Prof. Satis Chandra **Vidyābhūsana.**—Materials for a flora of the Malayan Peninsula, No. 17: Sir George **King,** F.R.S., and J. S. **Gamble,** F.R.S. This contribution commences with natural order Myrsineæ, and is continued by Sapotaceæ, Ebenaceæ, Styraceæ, and Oleaceæ. The draft of Ebenaceæ was prepared by Sir George King, that of the other orders by Mr. J. S. Gamble; but the new species are given under their joint names.

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THURSDAY, AUGUST 17, 1905.

THE MATHEMATICS OF NAVAL STRATEGY AND TACTICS.

Manuel Pratique de Cinematique navale et maritime. By Captain Leon Vidal. Pp. viii+171. (Paris: Gauthier-Villars, 1905.) Price 7.50 francs.

THIS book was undertaken by the author in accordance with instructions from the Minister of Marine issued seven years ago. Captain Vidal was directed to collect in a single volume the numerous essays on mathematical naval tactics contributed by various authors, French and foreign, and scattered over many publications. Officers of the French Navy were asked officially to give all possible assistance to the compiler, and many of them have done so. The laborious task has been admirably performed, various problems dealt with have been classified, and those relating to similar subjects have been grouped in distinct chapters. Captain Vidal has drawn largely upon work done by other officers, and acknowledges the fact. He is an enthusiast on the subject and has supplemented theorems due to others by much original work, extending or completing his scheme. Solutions alone are given and detailed demonstrations are avoided, so that the volume is compressed within narrow limits in proportion to the range and variety of subjects dealt with. In order to facilitate the practical use of his book by naval officers, elaborate numerical tables have been calculated by which readers can construct diagrams representing particular cases that may require to be dealt with either during naval manœuvres or in warlike operations. Numerous illustrations are introduced, and the descriptions are brief and clear throughout. Captain Vidal had to examine and collate an enormous mass of material produced during the last thirty years, and it is not surprising, therefore, that he has been so long engaged on the book. French naval officers and professors have done most in this field, but foreign authorities have also been laid under contribution, and the volume will probably long remain the chief book of reference on its special subject.

The science of naval cinematics, says the author, "consists in the study of the movements of vessels considered ordinarily as moving points, but in many instances it also takes account of their length and gyration, as well as their powers." For the most part, in the strategical theorems dealt with it has been assumed that ships may be treated as particles, the influence of length and turning-power being neglected. Further, it is generally assumed that movements take place in a calm and tideless sea. Certain corrections are suggested subsequently in order to make allowance for wind, wave, and current, but these sections are very brief, besides being incomplete in treatment, as is indeed unavoidable from the nature of the case. The turning-powers of steamships are but lightly touched, although they are most important in tactical manœuvres either for single ships or squadrons.

It is well known that the mathematical training of French naval officers is more extensive than that given to officers in the Royal Navy, and Captain Vidal is exceptionally well equipped in this respect, even among French officers. The book is indeed mainly a collection of geometrical theorems, in two dimensions, bearing upon the movements of ships or squadrons performed under certain assumed conditions. Many of these theorems can have little practical value, but not a few have been made the basis of modern French naval manœuvres. The fundamental idea is that when the course of a ship departs from a straight line it may be assumed to follow a logarithmic spiral. Captain Vidal enumerates the principal properties of that curve, and gives tables for estimating the lengths of arcs and chords, the values of tangents at different points, and other useful items. He takes special cases for spirals described about a fixed point, or about a point in the rectilineal course of another moving body, so as to examine the relative positions, from instant to instant, of two vessels or two squadrons. Theorems attaching to the well-known "curves of search" employed by ships when scouting, or endeavouring to detect the position of an enemy who attempts either to arrive at or depart from some fixed point, are discussed at length. In another chapter theorems dealing with the movements of two vessels such as may take place in single-ship actions are grouped and discussed fully. In a third chapter the most effective methods of concentration for scattered ships belonging to a fleet sent out for purposes of observation and scouting are dealt with. In another section the "lines of observation" to be patrolled by ships of a fleet, and the organisation required in order that an enemy cannot pass through the line without detection, are discussed. The influences of currents in rivers on the movements of vessels and the effect of wind and sea are also briefly investigated.

Captain Vidal writes fully as much as a mathematician as a naval officer. In his opinion the study of mathematics is both necessary and beneficial to all naval officers, whose duty he considers it to be to lay down conditions for programmes of ship-construction. Consequently he urges that officers should understand the work of the engineer and the trend of industrial progress if they are to give good advice and be the *corps directeur* of a modern fleet. Naval officers must, in his opinion, "make, in war, the synthesis of actual forces and guide them in producing the desired effects." To ensure success in this high mission the study of naval cinematics is essential, in Captain Vidal's judgment, since every advance in that science "enables one to foresee more clearly the results of movements of ships and to employ new combinations with intelligence." There is much force in this contention, but the class of work dealt with by Captain Vidal could be undertaken only by the *élite* of officers in the Royal Navy. His treatment would be over the heads of average naval men, and it is not likely to assist them in their daily work. The fact that the standard of mathematical attainment by average officers in our naval service is not so high

as in the French Navy may reduce the number of English readers of the book. But, happily, we possess many naval officers fully competent to take their place in scientific discussions of naval strategy and tactics. They will find much that is suggestive in Captain Vidal's book, and may be trusted to appreciate its investigations properly as well as to deduce therefrom rules for guidance, which will assist brother officers not so well instructed as themselves in the practical application of the theorems which Captain Vidal has collected. Shortly stated, the volume is better suited for the student than for the average naval officer, but it deserves a place in the professional libraries of all modern fleets.

W. H. WHITE.

THE CORRESPONDENCE OF HUYGENS.

Œuvres complètes de Christiaan Huygens. Publiées par la Société Hollandaise des Sciences. Tome dixième. Correspondance 1691–1695. Pp. 816. (Nijhoff: La Haye, 1905.)

THIS volume completes the publication of the scientific and miscellaneous letters of Huygens, the ten volumes comprising in all twenty-nine hundred letters and memoranda. There is, perhaps, not so much variety in the contents of the present volume as in those of previous ones, and the great majority of the letters of interest written during the last five years of Huygens's life have been published before, but they have now in many cases been further illustrated by the addition of rough notes from the books of adversaria of the author.

The correspondence with Leibnitz, which had been resumed in 1688 after a long interruption, went on regularly during the years 1691–5, dealing partly with pure mathematics, partly with the theory of universal gravitation. It shows that Huygens never became reconciled to the use of the differential calculus, but continued to prefer geometrical methods. In 1691 he acknowledges the utility of the calculus, and says that he has made some progress in it; yet in the very last letter to Leibnitz (of December 27, 1694) Huygens remarks that the new method "ne me demeure pas présente à l'esprit quand j'ai discontinué longtemps à m'y exercer." But the numerous letters and notes on the quadrature of curves, especially of the folium of Descartes, exchanged between Marquis de l'Hospital and Huygens show that the latter's power of dealing with geometrical problems was as vigorous as ever. He also continued to correspond with Fatio de Duillier, whose letters foreshadow the accusation of plagiarism which he launched against Leibnitz in 1699, as he from 1691 repeatedly assured Huygens that Newton was the discoverer of the differential calculus, and that it would not be pleasant for Leibnitz if Newton's letters to him were published. Huygens, who continued to think the new calculus unnecessary, did not omit to tell Leibnitz that, according to Fatio, Newton knew more of the inverse problem of tangents than Fatio and Leibnitz did; to which Leibnitz quietly replied that everybody had his own ways of proceeding, and perhaps he knew of some which Newton had not yet perceived. Fatio several times mentioned in his letters that he intended to publish a new edition of the "Principia," as Newton had declined to do it himself, and proposed to expand it into a folio volume, which he flattered himself would be more easily understood than Newton's quarto.

With Leibnitz, Huygens also exchanged ideas about the nature and cause of gravitation. In 1692 Leibnitz remarked that a vortex like that assumed by Descartes is necessary to explain why the earth's axis remains parallel to itself, while the fact that all planets and satellites move in the same direction also points to their being carried along by some fluid matter. He rejects the idea of Cassini, that the orbit of a planet is not an ellipse, but a Cassinian oval, since no physical reason had been given for this hypothesis. The spherical shape of a drop of water, the fall of a body to the earth, and the motion of the planets are all, according to Leibnitz, caused by the "materia ambiens." Huygens, on the other hand, thinks that the sphericity of a drop is more likely caused by the rapid motion of some matter which circulates inside, and as to the planets he fails to see why we should assume the existence of vortices when Newton had proved that the law of inverse squares "with the centrifugal force" produces the ellipses of Kepler. He also makes other objections to the theory of Descartes, particularly to the small spheres of the second element which revolve round the accumulated first element (the sun), and are supposed to have been formed by the corners of the original matter being rubbed off; for if this matter offered any resistance to this rubbing, what should limit the resistance, and if there were none, what should prevent the total destruction of the particles? The vortex which should preserve the parallelism of the earth's axis is incompatible with the motion of the same matter in all directions which should produce gravitation; an objection to which Leibnitz could only reply that we have two such independent circulations here on the earth, causing gravity and magnetism. Huygens acknowledges that vortices are a convenient means of explaining the common direction of planetary motions, but the constant eccentricity of a planet and the variable velocity in the orbit cannot be accounted for by the theory.

In this connection it is most interesting to read some notes written by Huygens to the well known "Vie de Monsieur Descartes," published anonymously by A. Baillet in 1691. According to Huygens, Descartes was very successful in getting his conjectures and fictions accepted as truth, just as novels may be taken for real history; but, on the other hand, he dealt with tangible things, and not with mere words as earlier philosophers had done. Bacon did not understand mathematics and was wanting in penetration as regards physics, being unable even to conceive the possibility of the earth's motion, which he mocked as an absurdity. Galileo had enough of mental power and mathematical knowledge to make progress in physical science, and he was the first to make discoveries as to the nature of motion, although

he left very much to be done. He did not pretend to explain the cause of all natural phenomena, nor had he the vanity to want to be the head of a sect; he was too modest and too great a lover of truth for that. But Descartes wanted to pass for the author of a new philosophy which could take the place of the Aristotelian, and he stuck to what he had once proposed though it was often very wrong. He has done a good deal of harm to the progress of philosophy, for those who believe in him imagine that they know the cause of everything; they waste time in sustaining the doctrines of their master, and do not work to penetrate the real reasons of the great number of phenomena as to which Descartes has only propounded idle fancies. A severe judgment, but not an undeserved one as regards the tenacity with which the followers of the Cartesian philosophy clung to the vortex theory, though it hardly accounted for any of the phenomena of planetary motion.

Probably owing to the infirmities of old age, Huygens during the period covered by this volume did not do any astronomical work, though he wrote to his brother Constantyn in 1693 that he had got a tube made for a 45-feet object glass, chiefly to show the moon and planets to persons of quality who could not manage a tubeless telescope, which was pointed to an object by cords. His interest in the use of pendulum clocks at sea was unabated, and there are several short letters on this subject. As the results of repeated trials were not favourable, Huygens endeavoured to find other means of realising isochronic motion, not subject to disturbance from the rolling of a ship, and designed several forms of balance of which a full account is to appear among his hitherto unpublished works.

There are fewer allusions to current political and other events in this volume than in the previous ones, but naturally the anti-Copernican action of the University of Louvain in 1691 is not passed over. The faculty of arts suspended Prof. van Welden for three years for asserting that the earth was one of the planets. He wrote to Huygens to beg for the intercession of Constantyn Huygens or of King William, but they do not appear to have done anything for him. During the last years of his life, Huygens wrote his well known little book "Cosmotheoros," which was not published until 1698, three years after the death of its author.

J. L. E. D.

PSYCHIATRY.

Manual of Psychiatry. By J. R. de Fursac. Translated by A. J. Rosanoff, and edited by Dr. J. Collins. Pp. xii+352. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 10*s.* 6*d.* net.

THE author has managed to compress a fairly large amount of information into this manual, but we are afraid that the subject-matter is almost too condensed for the reader who is not already conversant with the subject. This book is divided into two parts. The first portion is a general study of the causes, symptoms, and treatment of mental disorder, considered independently of the various affections in which they are encountered. The second portion is devoted to the study of the individual psychoses.

The volume is rather unevenly divided; some subjects are fully dealt with, but the description of others is somewhat meagre. The chapter on ætiology is very good, and this important problem is thoroughly reviewed. We cannot agree with the author in his conclusion that heart disease is common in the insane, and Strecker's figures as to the prevalency of this malady in German asylums, viz. 61.7 per cent for men and 42.7 per cent. for women, would not coincide with similar statistics obtained from English asylums.

In the chapter on general symptomatology the subject of hallucinations and their causation is briefly but well described. Throughout the volume it is very noticeable that purely psychological matters are dealt with in greater detail than other subjects of equal, if not of greater, interest to the practical physician. For example, the pages on treatment are undoubtedly the weakest in the book. Very little space is devoted to this important subject, and the reader is left very much in the dark as to the management of cases of mental disorder.

The author has evidently had the usual difficulty in finding a good classification of insanity. He states that in the absence of one that is founded upon a pathological anatomy basis he has chosen "the most practical, the most convenient, and the one which in any given case would enable us to establish the prognosis and institute the treatment." We quite agree that he has made the best choice in selecting Kraepelin's classification as the basis for his own scheme.

The first chapter in the second part is reserved for the consideration of the "infectious psychoses," of which the following are briefly reviewed:—febrile delirium, infectious delirium, and hydrophobia.

Under the heading of "Psychoses of Exhaustion," the author describes conditions of primary mental confusion and acute delirium. Toxic psychoses are divided into two divisions, (*a*) acute, (*b*) chronic, morphinomania and cocainomania being included in the second class. Dr. de Fursac recommends that, when possible, the rapid method of withdrawal of morphia should be employed in the treatment of morphinism, as he prefers this to the sudden and gradual methods sometimes employed.

The "autointoxication psychoses" include uræmia, the polyneuritic psychosis or Korsakoff's disease, dementia præcox, and general paresis. After thoroughly considering the relationship of syphilis to general paresis, the author states that "at the present time we have no conclusive evidence either for or against the syphilitic origin of general paresis."

The next chapters are devoted to the description of "psychoses dependent upon so-called organic cerebral affections," and "psychoses of involution." The latter include "affective melancholia" and "senile dementia." We do not like the term "affective melancholia"; it seems redundant, for clearly all forms of depression must be affective. Further, the author uses the term in a new sense, which causes

confusion. The chapter on senile dementia is distinctly good and very instructive.

Under "psychoses without a well-determined etiology, which are apparently based upon a morbid predisposition," are found manic-depressive insanity, paranoia, and constitutional psychopathic conditions, such as mental instability, sexual perversions and inversions and obsessions. Paranoia is very briefly described under the title of "Reasoning Insanity." We strongly disagree with the author in his use of this term; it is by no means a good one, and is, in addition, confusing, since other writers have used it as designating the maniacal stage of manic-depressive insanity.

Epilepsy and hysteria are described under the heading of "Psychoses Based on Neuroses," and the concluding chapter is devoted to the consideration of the arrest of mental development.

The book is well translated, and the index is carefully compiled. This manual undoubtedly has its merits, but, as we have already stated, it will scarcely appeal to the practitioner, as the description of treatment is somewhat meagre, and the student will find the subject-matter almost too condensed. In any future edition the author will do well to correct these defects, for by so doing he will render his book a useful manual on psychiatry.

OUR BOOK SHELF.

Experiments with Plants. By Dr. W. J. V. Osterhout. Pp. x+492; illustrated. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1905.) Price 5*s.* net.

THE author defines his aims in the following words (p. 7):—"The numerous questions which young people ask about plants are best answered by themselves. . . . To put them in the way of doing this so far as possible is the object of this book." In accordance with this plan, the apparatus used is of a rough and home-made description, constructed of fruit jars, lamp chimneys, clothes' pegs, india-rubber bands, and sealing-wax. Much ingenuity is shown in the design of apparatus so put together. Whether a sufficient degree of stability is always obtainable may perhaps be questioned, but from the author's point of view the advantages of his method certainly outweigh any such shortcomings. One great merit in the book is the insistence on the necessity of control experiments, which are especially needful with rough methods. The book is divided into chapters headed "The Work of Roots"—of leaves, of stems, &c.—ending up with a chapter on "Making New Kinds of Plants," which is a statement of what breeders and experimenters on variability have done rather than instructions for the making of such experiments.

The author very properly recommends common plants for use; but why students of botany should be confined to such names as "Kentucky Coffee Tree," "Dusty Miller," "Live Forever," "Switch Plant," it is difficult to say. Occasionally we find the scientific name, and in this way we learn that a "Wandering Jew" is a Tradescantia.

Most of the experiments are clearly described, but we have been puzzled over some of them. For instance (p. 191), the method of answering the question, "Does the leaf decompose carbon dioxide?" seems to us to involve passing a lighted candle under water into a jar of air. Here and elsewhere in the book the author neglects simple and striking methods. It is important that the student should be convinced that oxygen is given off by green leaves in light. The above-mentioned experiment is not satisfactory, whereas Engelmann's blood method is both simple and convincing. Again, the well-known plan of counting the bubbles given off by submerged plants in light, though not free from errors, gives useful comparative data for the study of assimilation. In the same way we think that more fundamental experiments should have been given under the heading of "Stomata." Stahl's cobalt method, which is merely mentioned in a note, can be used by the most elementary of students to demonstrate important facts.

In spite of some faults, the book will be found of value to anyone compelled to give a course of physiological botany under conditions which preclude the use of ordinary laboratory fittings.

Conversations on Chemistry. Part i. General Chemistry. By W. Ostwald. Authorised translation by Elizabeth Catherine Ramsay. Pp. v+250. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 6*s.* 6*d.* net.

THE German original of this book has already received sympathetic notice in NATURE, and in connection with the translation now before us it is necessary to add little more than that Miss Ramsay has done her work with much skill, and has made the dialogue not less natural and vivacious than it is in the original. It is impossible to read the book without a feeling of refreshment and amusement, or without admiration of the ingenuity and resource of its philosophical author. It seems hardly fair to say that we have here a revival of Dr. Brewer or Mrs. Marcet. There are two striking differences between the old and the new dialogues. In the first place neither master nor pupil in Prof. Ostwald's book is endowed with that austere and depressing piety of mind which, to the unregenerate, provided perhaps the most afflicting feature of the older works. In the second place Prof. Ostwald's book shows a masterly treatment not only of the real difficulties of chemistry in itself, but a perfect appreciation of the pitfalls that beset the pupil in the early stages of learning. It is difficult to suppose that any teacher will fail to find something useful or to gain some valuable hints from reading the book, and on this ground it must be warmly recommended.

It would, however, be a misfortune if a teacher constrained his teaching to the exact course of the dialogue, and, of course, it would be worse still if he set so many pages as a lesson to be learned by the pupil. The real usefulness of the book will probably lie in the example it affords of the life that may be imparted to teaching when, on the one hand, the pupil is allowed a fair chance of thinking out things for himself and a full opportunity of frankly saying what he thinks, and when, on the other hand, the teacher takes the part of a guide, philosopher, and friend who has a soul above dictionaries and examination papers. A. S.

Mathematical Recreations and Essays. By W. W. Rouse Ball. Fourth edition. Pp. xvi+402. (London: Macmillan and Co., Ltd., 1905.) Price 7*s.* net.

THIS edition differs from the third by containing chapters on the history of the mathematical tripos at Cambridge, Mersenne's numbers, and cryptography and ciphers, besides descriptions of some mathematical recreations previously omitted. The book has thus become more miscellaneous in character, but the additions fit in very well, and are all entertaining. Mr. Ball writes with enjoyment of his subject, and

in a very agreeable style; moreover, he does not assume the reader to possess any knowledge of advanced mathematics. For those who wish to study any of the more important topics in detail he gives ample references; for those merely in search of diversion he provides a mine of amusement, in exploring which many pleasant hours may be spent. And there are some unsolved problems mentioned which the amateur with a mathematical turn of mind may attack with nearly as much chance of success as the expert; for instance, to give a strict proof that only four different colours are necessary to colour a map distinctly. Altogether this is an excellent work of its kind, and ought to find a large number of readers; even those who have a former edition will be likely to buy this one, if only for the sake of the very interesting account of the vicissitudes of the mathematical tripos.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Rate of Formation of Radium.

THE production of radium from uranium has now been observed experimentally; the rate of production is not, however, in accordance with the quantitative theory. Mr. Soddy's observations (*Phil. Mag.*, June, 1905) gave a rate of production of only one-thousandth of the theoretical amount. An experiment which I made on a specimen of uranium salt, known to be at least thirty years old, has confirmed Mr. Soddy's conclusion so far as to show that the mean rate of production of radium could not have exceeded a hundredth part of the theoretical amount. It may, of course, have been much less, since the amount of radium initially present is unknown.

The explanation of this discrepancy, which has been suggested by Mr. Soddy and others, is that there may be a transitional product. If this is the case, it is to be expected that the rate of production of radium from uranium initially purified will be found to accelerate as time goes on. In the meantime, I am trying an experiment which promises to give the required information more easily.

The transitional product, if it exists, must be contained in pitchblende. If, therefore, we could remove all the radium, but as little else as possible, from a solution of pitchblende, the increased rate of production of radium might be apparent.

Fifty grams of the best pitchblende were dissolved in nitric acid. The insoluble residue was fused with sodium carbonate and added to the solution. The whole was evaporated to small bulk to render silica insoluble; more dilute acid was added, and the silica filtered off and rejected. The metallic bases were thus got into solution.

The solution was freed from radium so far as possible by adding barium nitrate solution in small portions, alternately with equivalent quantities of potassium sulphate. Four and a half grams of the barium salt were thus added. After this the amount of radium remaining was determined by its emanation; three determinations gave, on an arbitrary scale, 69, 58·5, 61·5, mean 63·0. After an interval of three and a half months the amount was again determined. The values were 73·5, 74·5, 72·0, 75·0, 72·5, mean 73·5. It appears probable that this increase is significant, since each of the second series of numbers is larger than any of the first series.

Assuming that the difference is significant, the rate of production per gram of mineral per year would be, on the same scale, 0·723. The equilibrium quantity of radium, the amount, that is, in the untreated mineral, was found to be, per gram, 10,100. If radium decays to one-half its initial quantity in a thousand years, as theory indicates, then the production in one year from a gram of the mineral should be $10,100/1{\cdot}45 \times 1000 = 6{\cdot}9$, about ten times the observed amount.

The increase is insufficient to inspire complete confidence. It seems most probable, however, that there is an increase much greater than in Mr. Soddy's experiments with pure uranium salts. It would not have been difficult to remove all traces of radium, and then the increase (if real) would have been unmistakable. It was feared, however, that the barium precipitation might remove part of the hypothetical intermediate product. It seems likely that this is the case, since the rate of production is still less than theory requires.

A little longer interval will, it is hoped, give a conclusive result. It is intended to try other methods of separating the radium, in the hope of avoiding all loss of the intermediate product.

R. J. STRUTT.

The Effect of Radium on the Strength of Threads.

IN a note which appeared in NATURE on February 4, 1904, Lord Blythswood announced his observation of the destructive action exerted on cambric by the radiation from radium. Having at our disposal recently twenty milligrams of radium bromide which had, for a time, nothing better to do, we investigated the progressive decrease of strength of threads exposed to its influence. In order to have examples of both animal and vegetable fibres, we used unspun silk and ordinary bleached cotton thread.

Ten pieces of thread were exposed at a time. The threads were folded round a strip of writing paper and held in place by being caught in notches cut in the edges of the strip. The paper was laid on the top of the capsule containing the radium, so that the ten threads were exposed to the bare radium at a distance of about half a centimetre. The whole was enclosed in a lead box. After a certain period of exposure the average breaking strength of the threads was taken and plotted against the time. The points obtained lay closely on a smoothly descending curve.

In the case of the silk fibres the loss of strength went on at a practically uniform rate from the beginning up to the longest duration of exposure given (seven days). The initial strength was 78 gms., and this decreased by about 4 gms. per day. The cotton threads, on the other hand, gave a curve which fell more rapidly in the early than in the later stages. The strength began at 370 gms., and decreased at first by about 60 gms. per day. After ten days the rate of weakening was about half this. The longest exposure given was seventeen days; at the end of this time the strength was reduced to 50 gms. The different behaviour of the two kinds of fibres may be due to the much greater thickness of the cotton threads.

The effect seemed to be due entirely to the α rays. A piece of paper was interposed between the threads and the radium, and three days' exposure was given. In the subsequent test none of the threads broke at the exposed part, and the strength was not decreased.

We tried the effect of moistening the cotton threads, the two ends of each thread being left, during a three days' exposure, dipping into a vessel of water. On opening the lead box, in which the whole arrangement was enclosed, it was found that the radium bromide, being hygroscopic, was wet and partially dissolved. The strength of the threads was found to be higher than when exposed in a dry condition for the same period. The difference was too great to be attributed to the increase of strength imparted to threads by moisture, and was plainly due to the decreased emission of rays accompanying the solution, and the consequent removal of the emanation from the radium. We traced the course of the recovery of activity by the dried radium by making a series of three-day exposures of dry threads. The effectiveness of the radiation as measured by the weakening of the threads came back by regular steps in about a fortnight to a value slightly greater than its original one. This may have been due to a re-arrangement of the upper surface of the powder, which was not, at the beginning, very regularly spread over the bottom of the capsule.

HILDA P. MARTIN.
W. B. MORTON.

Queen's College, Belfast, August 8.

AMERICAN RESEARCH IN ASIA.[1]

THIS handsome publication is divided into six sections, Prof. Pumpelly describing the "archeological" and physicogeographical reconnaissance in Turkestan, and Mr. R. W. Pumpelly the physiographic observations on the Pamir; Prof. W. M. Davis describes "a journey across Turkestan," and Mr. Ellsworth Huntington deals with Central Turkestan and with the basin of eastern Persia and Sistan.

The expedition received the most friendly help from the Russian authorities, and received its only check in northern Afghanistan. The dominant factor in the wide region examined appears to be its progressive desiccation, whereby even the irrigation works of the ancient races failed long ago to bring in water from the streams. Everywhere there are signs of old vitality, of great cities, and of peoples who accumulated wealth by trade and settled labour. Again and again, envious invaders from the south, or east, or west, have swept across the hollow lands between the mountains, and have destroyed a civilisation in order to enforce their own. The very sites of the chief towns have shifted, and the remains of the earlier settlements, deeply buried, may afford a clue to "the origin of Western and Eastern civilisations."

Prof. W. M. Davis, experienced in grasping the significance of the surface-features of a country, discusses the former extension of the waters in the Aralo-Caspian area. Particular interest also attaches to his examination of the loess. Whatever the actual origin of this finely divided material, there is no doubt as to its distribution and the moulding of its surface by wind in the eastern provinces of Semiryetshensk and Fergana (p. 63)—we adopt the spelling of the text, and not of the map which forms plate iii. Mr. Huntington also observes loess in process of formation in the Kashgar plain, and refers it here to the spreading out of very fine silt by water in the flat floor of temporary and recurrent lakes. There is in reality no contradiction between these views, since most writers are agreed that the material gathers first of all in the plains by ordinary processes of denudation, and then undergoes further sifting, the chief agent being the persistent action of the wind.

Both these authors believe that the Tian Shan mountains were worn down to a fairly uniform surface after their principal folding had occurred, and that they owe their present irregular surface more to subsequent differential uplifts than to denudation (pp. 73, 80, 168, &c.). "Even in the lofty Pamir there are certain ranges where the snowy peaks are smoothly truncated, as though by the old peneplain, in spite of the fact that they are from 15,000 to 20,000 feet high." Prof. Davis seems not to insist on so recent a date for the "peneplain" as does his colleague, who brings forward conclusive evidence that the whole Tertiary series of the district was involved in the folding, and that the uniform degradation must be assigned to late Tertiary times. The present development of the "peneplain" in Central Turkestan seems, according to Mr. Huntington, due to the formation of ridges and basins, without conspicuous faulting. Prof. Davis, on his part, lays more stress on faults and "fault-blocks." Lateral compression, he urges, has had little to do with the raising of the block-ranges, to which our attention is now for the first time directed in this area; and he proceeds, in consequence, to consider the bearing of the Tian Shan ranges on Suess's views on horsts. He justly remarks (p. 82) that "forces of uplift are

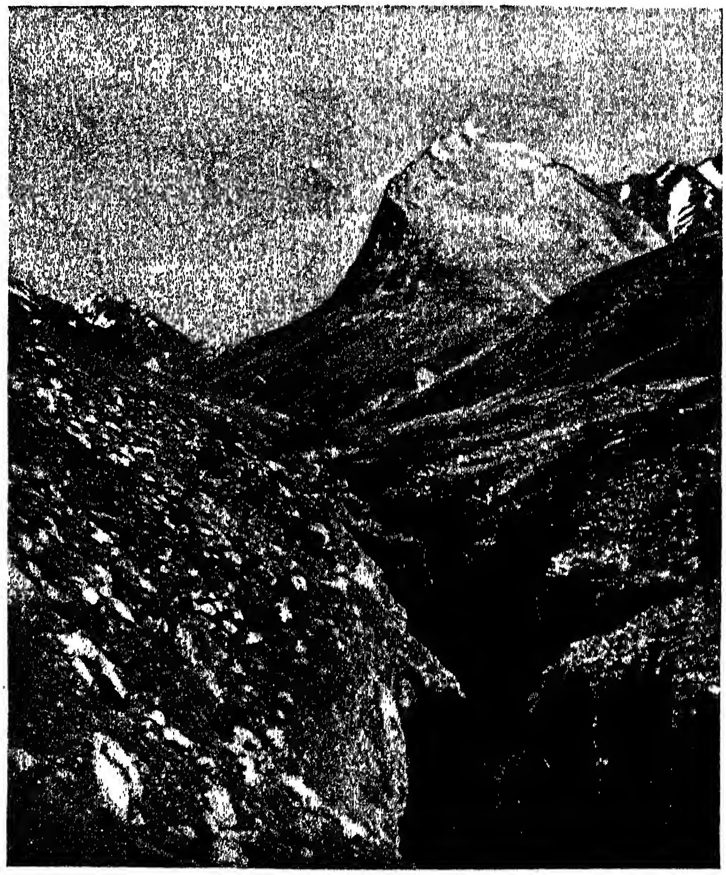


FIG. 1.—Youngest Gorge of the Khoja Ishken, cut in the bottom of the main Glacial Valley. From "Explorations in Turkestan, with an Account of the Basin of Eastern Persia and Sistan."

still worthy of consideration"; and, being himself a profound student of processes of denudation, he points out that the surfaces of many horsts must have been near sea-level before they were separated by dislocation. After all, may we not be grateful to Suess when we find discussions such as these arising naturally in a work of travel, which might in some hands have been a record of detached geological observations?

The glacial phenomena of the central ranges are described in connection with the successive areas studied, and the gravel terraces, which are well illustrated by views and sections, are correlated with climatic changes. The authors hope that subsequent

[1] "Explorations in Turkestan, with an Account of the Basin of Eastern Persia and Sistan." Expedition of the Carnegie Institution of Washington in 1903, under the direction of Raphael Pumpelly. Pp. xii+324; with map plates, and figures in the text. (Washington: Carnegie Institution, 1905.)

researches may indicate fluctuations in the Aralo-Caspian waters, in correspondence with those traceable in the rivers that flowed down from the glaciated areas. Mr. R. W. Pumpelly tried, in the short time at his disposal, to correlate (p. 143) the glacial changes with the successive shorelines traceable in the basin of Kara Kul on the Pamir, and makes the interesting suggestion that this lake rose to a height of 320 feet or more above its present level during the first local glacial epoch, and to a height of 150 feet during the second epoch, the times of greatest precipitation corresponding with the increase in the lacustrine waters. Both here and in the Alai Valley to the north, two well marked series of moraines exist. The older series in the Alai Valley is clearly indicated by being cut into by the narrower valley-troughs, with which the second and fresher series is associated. If we read Mr. Pumpelly aright—for his mode of bringing together his observations leaves something to be desired and explained—the older glacial epoch actually preceded some of the earth-movements which gave the ranges their present relations and elevations (pp. 145 and 155).

Mr. Huntington goes so far as the presentation of five glacial epochs, on the evidence of the large and high-reaching valleys which still contain glaciers in them (p. 199); and, arguing from the very probable

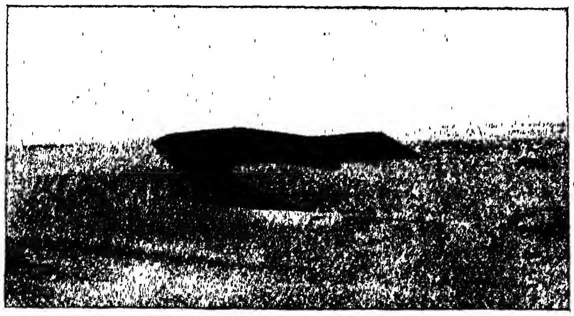


FIG. 2.—A Barkhan near Bakharden, looking south. From "Explorations in Turkestan, with an Account of the Basin of Eastern Persia and Sistan."

correlation of his epochs of gravel-deposition and of glacial extension higher up the country, he is inclined to ask for at least six advances and six considerable "interglacial" withdrawals of the ice. In his concluding paper on eastern Persia and Sistan, he describes what he styles "one of the most desolate lands in the world," "a land of gravel and nakedness, of huge desert basins and desolate, interminable slopes, of tantalizing mirages and bare mountains." The average rainfall does not rise above 10 inches, and comes from the south-east; while the summer wind from the north, often as violent as a hurricane, fills the air for four arid months with continental dust. The country is dealt with by Mr. Huntington as by a scientific artist, and his picturesque touch is emphasised by an occasional aphorism, such as "The desert makes men lose every sentiment except the desire to get safely to the other side." Persia is to him a "typical example of an arid country"; and he gives us a fine sketch of its life-history. He then describes in detail five series of recent river-terraces, and connects them, as we are led by this time to expect, with climatic changes, similar to those in Turkestan. The alternations in the lake-deposits of Sistan then come in for corresponding treatment, and the decay of the area in population and in political power in modern times is attributed to the final desiccation.

We are glad that Mr. Huntington's clearly written papers close the series; for must we not admit that American physical geographers, who are apt to classify old conceptions until they appear to develop into new ones, provide us at times with somewhat difficult reading? On p. 79 we have:—"the peneplanation of the region improved in the final 40 miles of the road on the sixth day. In the morning some of the broad ridges . . . were from 300 to 500 feet over the intervales." Mr. Pumpelly can hardly be a cyclist, or he would not speak of "deflated bowlders" on p. 131. If, again, we all understand what dating a letter means, how shall we appreciate the phrase (p. 135) "the epochs predating the escarpments"? We make these remarks as much in the interest of the conscientious foreigner as of ourselves; for the directors of the publications of the Carnegie Institution have no right and no desire to remain content with a purely American circulation.

As examples of the numerous effective illustrations, we may mention the photograph of a characteristic crescent-shaped "barkhan" of blown sand on p. 44, and that of the glacial valley and subsequent ravine of the Khoja Ishken on p. 188, both of which are here reproduced; but all throughout are to the purpose, even when merely showing modes of travel in a region of absorbing interest.

GRENVILLE A. J. COLE.

HABITS OF BIRDS.[1]

MR. EDMUND SELOUS, the author of this elegant little volume, is one of the most patient and enthusiastic observers of bird-life in the British Islands, and has recorded details in connection with the habits of several species which have been overlooked by other field-naturalists. If the riddle of nature is ever to be solved by observations on living animals, Mr. Selous is one of the men who ought to help to solve it, although we are bound to confess that several of his theories, notably the one with regard to the origin of the nest-making instinct, do not appear to ourselves by any means convincing or sufficient. Nests, indeed, form a very favourite theme of the author; so much so, in fact, that when discussing the building of supernumerary nests by various species on pp. 67 and 199, he practically repeats the same thing, namely, that this results, originally, from a simple love of labour and occupation.

The author is, perhaps, at his best when describing the movements and actions of birds as seen during his inimitably patient watchings, excellent examples of this being shown in his description of herons alighting on their nest, and of long-tailed titmice constructing the domed receptacle in which their eggs are deposited. The latter incident is represented in one of the illustrations, photographed, like the rest, from a sketch by the clever pencil of Mr. Lodge, this exquisite picture being reproduced as a sample of the illustrations generally. As an interesting suggestion, reference may be made to the author's theory that when a woodpecker's nesting hole has been usurped by a starling, the rightful owner may occasionally lay an egg in the nest, and that in this manner the parasitic habit of the cuckoo may have been developed. The fact of starlings excavating large nesting chambers in sand-cliffs is entirely new to us.

In regard to the "get-up" of the book, we may suggest that it would have been an improvement if, instead of repeating the main title as the heading for alternate pages, the name of the species under dis-

[1] "Bird Life Glimpses." By E. Selous. Pp. viii+335; illustrated. (London: G. Allen, 1905.) Price 6s. net.

cussion had been given, for, in consequence of the vague headings on the opposite pages, it is often a matter of some little difficulty to discover to which particular bird the author is referring. Throughout his volume Mr. Selous is fond of interpolating phrases or quotations in foreign languages, inclusive of French, German, Latin, and Greek. Whether such a practice is altogether desirable may be a matter of opinion, but there will be only one opinion as to the desirability of quoting correctly, which is far from being the case when a well-known line from the second book of the Æneid is introduced on p. 109.

R. L.

FIG. 1.—Long-tailed Tits and the Nest. From E. Selous's "Bird Life Glimpses."

THE SOUTH AFRICAN MEETING OF THE BRITISH ASSOCIATION.

THE seventy-fifth meeting of the British Association was inaugurated at Cape Town on Tuesday, when the president, Prof. G. H. Darwin, F.R.S., delivered the first portion of his address to a large gathering in the new City Hall. This part is reprinted below, and the remainder of the address, to be delivered at Johannesburg on Wednesday, August 30, will appear in NATURE of the following day.

From a Reuter message we learn that on the conclusion of the address, the Governor, Sir Walter Hely-Hutchinson, in proposing a vote of thanks, bade the association heartily welcome on behalf of Cape Colony. The occasion was one, he said, of no ordinary importance, whether in the history of the development of scientific inquiry or in the history of the relations of the United Kingdom with the British dominions beyond the seas. He hoped it would be found that a great and important step had been taken in drawing closer together the bonds of the brotherhood of science, and, it might be, through the brotherhood of science, in promoting and developing brotherly feeling between His Majesty's subjects in South Africa and the Motherland.

Sir David Gill, K.C.B., chairman of the central organising committee at Cape Town, seconded the motion; and a brief reply by Prof. Darwin brought the proceedings to a close.

The addresses of all the presidents of sections were to be delivered yesterday on the assembling of the sections at Cape Town. The sections are also to meet for the reading and discussion of reports and papers to-day and to-morrow, and they will reassemble on Tuesday, August 29, at Johannesburg, where the concluding meeting will be held on September 1, and the work of the sections will terminate.

INAUGURAL ADDRESS BY PROF. G. H. DARWIN, M.A., LL.D., PH.D., F.R.S., PRESIDENT OF THE ASSOCIATION.

PART I.

BARTHOLOMEU DIAZ, the discoverer of the Cape of Storms, spent sixteen months on his voyage, and the little flotilla of Vasco da Gama, sailing from Lisbon on July 8, 1497, only reached the Cape in the middle of November. These bold men, sailing in their puny fishing smacks to unknown lands, met the perils of the sea and the attacks of savages with equal courage. How great was the danger of such a voyage may be gathered from the fact that less than half the men who sailed with da Gama lived to return to Lisbon. Four hundred and eight years have passed since that voyage, and a ship of 13,000 tons has just brought us here, in safety and luxury, in but little more than a fortnight.

How striking are the contrasts presented by these events! On the one hand compare the courage, the endurance, and the persistence of the early navigators with the little that has been demanded of us; on the other hand consider how much man's power over the forces of nature has been augmented during the past four centuries. The capacity for heroism is probably undiminished, but certainly the occasions are now rarer when it is demanded of us. If we are heroes, at least but few of us ever find it out, and, when we read stories of ancient feats of courage, it is hard to prevent an uneasy thought that, notwithstanding our boasted mechanical inventions, we are perhaps degenerate descendants of our great predecessors.

Yet the thought that to-day is less romantic and less heroic than yesterday has its consolation, for it means,

that the lot of man is easier than it was. Mankind, indeed, may be justly proud that this improvement has been due to the successive efforts of each generation to add to the heritage of knowledge handed down to it by its predecessors, whereby we have been born to the accumulated endowment of centuries of genius and labour.

I am told that in the United States the phrase "I want to know" has lost the simple meaning implied by the words, and has become a mere exclamation of surprise. Such a conventional expression could hardly have gained currency except amongst a people who aspire to knowledge. The dominance of the European race in America, Australasia, and South Africa has no doubt arisen from many causes, but amongst these perhaps the chief one is that not only do "we want to know," but also that we are determined to find out. And now within the last quarter of a century we have welcomed into the ranks of those who "want to know" an oriental race, which has already proved itself strong in the peaceful arts of knowledge.

I take it, then, that you have invited us because you want to know what is worth knowing; and we are here because we want to know you, to learn what you have to tell us, and to see that South Africa of which we have heard so much.

The hospitality which you are offering us is so lavish, and the journeys which you have organised are so extensive, that the cynical observer might be tempted to describe our meeting as the largest picnic on record. Although we intend to enjoy our picnic with all our hearts, yet I should like to tell the cynic, if he is here, that perhaps the most important object of these conferences is the opportunity they afford for personal intercourse between men of like minds who live at the remotest corners of the earth.

We shall pass through your land with the speed and the voracity of a flight of locusts; but, unlike the locust, we shall, I hope, leave behind us permanent fertilisation in the form of stimulated scientific and educational activity. And this result will ensue whether or not we who have come from Europe are able worthily to sustain the lofty part of prophets of science. We shall try our best to play to your satisfaction on the great stage upon which you call on us to act, and if when we are gone you shall, amongst yourselves, pronounce the performance a poor one, yet the fact will remain, that this meeting has embodied in a material form the desire that the progress of this great continent shall not be merely material; and such an aspiration secures its own fulfilment. However small may be the tangible results of our meeting, we shall always be proud to have been associated with you in your efforts for the advancement of science.

We do not know whether the last hundred years will be regarded for ever as the *saeculum mirabile* of discovery, or whether it is but the prelude to yet more marvellous centuries. To us living men, who scarcely pass a year of our lives without witnessing some new marvel of discovery or invention, the rate at which the development of knowledge proceeds is truly astonishing; but from a wider point of view the scale of time is relatively unimportant, for the universe is leisurely in its procedure. Whether the changes which we witness be fast or slow, they form a part of a long sequence of events which begin in some past of immeasurable remoteness and tend to some end which we cannot foresee. It must always be profoundly interesting to the mind of man to trace successive cause and effect in the chain of events which make up the history of the earth and all that lives on it, and to speculate on the origin and future fate of animals, and of planets, suns, and stars. I shall try, then, to set forth in my address some of the attempts which have been made to formulate evolutionary speculation. This choice of a subject has, moreover, been almost forced on me by the scope of my own scientific work, and it is, I think, justified by the name which I bear. It will be my fault and your misfortune if I fail to convey to you some part of the interest which is naturally inherent in such researches.

The man who propounds a theory of evolution is attempting to reconstruct the history of the past by means of the circumstantial evidence afforded by the present. The historian of man, on the other hand, has the advantage over the evolutionist in that he has the written records of the past on which to rely. The discrimination of the truth from amongst discordant records is frequently a work demanding the highest qualities of judgment; yet when this end is attained it remains for the historian to convert the arid skeleton of facts into a living whole by clothing it with the flesh of human motives and impulses. For this part of his task he needs much of that power of entering into the spirit of other men's lives which goes to the making of a poet. Thus the historian should possess not only the patience of the man of science in the analysis of facts, but also the imagination of the poet to grasp what the facts have meant. Such a combination is rarely to be found in equal perfection on both sides, and it would not be hard to analyse the works of great historians so as to see which quality was predominant in each of them.

The evolutionist is spared the surpassing difficulty of the human element, yet he also needs imagination, although of a different character from that of the historian. In its lowest form his imagination is that of the detective who reconstructs the story of a crime; in its highest it demands the power of breaking loose from all the trammels of convention and education, and of imagining something which has never occurred to the mind of man before. In every case the evolutionist must form a theory for the facts before him, and the great theorist is only to be distinguished from the fantastic fool by the sobriety of his judgment—a distinction, however, sufficient to make one rare and the other only too common.

The test of a scientific theory lies in the number of facts which it groups into a connected whole; it ought besides to be fruitful in pointing the way to the discovery and coordination of new and previously unsuspected facts. Thus a good theory is in effect a cyclopædia of knowledge, susceptible of indefinite extension by the addition of supplementary volumes.

Hardly any theory is all true, and many are not all false. A theory may be essentially at fault and yet point the way to truth, and so justify its temporary existence. We should not, therefore, totally reject one or other of two rival theories on the ground that they seem, with our present knowledge, mutually inconsistent, for it is likely that both may contain important elements of truth. The theories of which I shall have to speak hereafter may often appear discordant with one another according to our present lights. Yet we must not scruple to pursue the several divergent lines of thought to their logical conclusions, relying on future discovery to eliminate the false and to reconcile together the truths which form part of each of them.

In the mouths of the unscientific evolution is often spoken of as almost synonymous with the evolution of the various species of animals on the earth, and this again is sometimes thought to be practically the same thing as the theory of natural selection. Of course those who are conversant with the history of scientific ideas are aware that a belief in the gradual and orderly transformation of nature, both animate and inanimate, is of great antiquity.

We may liken the facts on which theories of evolution are based to a confused heap of beads, from which a keen-sighted searcher after truth picks out and strings together a few which happen to catch his eye, as possessing certain resemblances. Until recently, theories of evolution in both realms of nature were partial and discontinuous, and the chains of facts were correspondingly short and disconnected. At length the theory of natural selection, by formulating the cause of the divergence of forms in the organic world from the parental stock, furnished the naturalist with a clue by which he examined the disordered mass of facts before him, and he was thus enabled to go far in deducing order where chaos had ruled before; but the problem of reducing the heap to perfect order will probably baffle the ingenuity of the investigator for ever.

So illuminating has been this new idea that, as the whole of nature has gradually been re-examined by its aid, thousands of new facts have been brought to light, and have been strung in due order on the necklace of knowledge. Indeed, the transformation resulting from the new

point of view has been so far-reaching as almost to justify the misapprehension of the unscientific as to the date when the doctrines of evolution first originated in the mind of man.

It is not my object, nor indeed am I competent, to examine the extent to which the theory of natural selection has needed modification since it was first formulated by my father and Wallace. But I am surely justified in maintaining that the general principle holds its place firmly as a permanent acquisition to modes of thought.

Evolutionary doctrines concerning inanimate nature, although of much older date than those which concern life, have been profoundly affected by the great impulse of which I have spoken. It has thus come about that the origin and history of the chemical elements and of stellar systems now occupy a far larger space in the scientific mind than was formerly the case. The subject which I shall discuss to-night is the extent to which ideas, parallel to those which have done so much towards elucidating the problems of life, hold good also in the world of matter; and I believe that it will be possible to show that in this respect there exists a resemblance between the two realms of nature, which is not merely fanciful. It is proper to add that so long ago as 1873 Baron Karl du Prel discussed the same subject from a similar point of view, in a book entitled "The Struggle for Life in the Heavens."[1]

Although inanimate matter moves under the action of forces which are incomparably simpler than those governing living beings, yet the problems of the physicist and the astronomer are scarcely less complex than those which present themselves to the biologist. The mystery of life remains as impenetrable as ever, and in his evolutionary speculations the biologist does not attempt to explain life itself, but, adopting as his unit the animal as a whole, discusses its relationships to other animals and to the surrounding conditions. The physicist, on the other hand, is irresistibly impelled to form theories as to the intimate constitution of the ultimate parts of matter, and he desires further to piece together the past histories and the future fates of planets, stars, and nebulæ. If then the speculations of the physicist seem in some respects less advanced than those of the biologist, it is chiefly because he is more ambitious in his aims. Physicists and astronomers have not yet found their Johannesburg or Kimberley; but although we are still mere prospectors, I am proposing to show you some of the dust and diamonds which we have already extracted from our surface mines.

The fundamental idea in the theory of natural selection is the persistence of those types of life which are adapted to their surrounding conditions, and the elimination by extermination of ill-adapted types. The struggle for life amongst forms possessing a greater or less degree of adaptation to slowly varying conditions is held to explain the gradual transmutation of species. Although a different phraseology is used when we speak of the physical world, yet the idea is essentially the same.

The point of view from which I wish you to consider the phenomena of the world of matter may be best explained if, in the first instance, I refer to political institutions, because we all understand, or fancy we understand, something of politics, whilst the problems of physics are commonly far less familiar to us. This illustration will have a further advantage in that it will not be a mere parable, but will involve the fundamental conception of the nature of evolution.

The complex interactions of man with man in a community are usually described by such comprehensive terms as the State, the Commonwealth, or the Government. Various States differ widely in their constitution and in the degree of the complexity of their organisation, and we classify them by various general terms, such as autocracy, aristocracy, or democracy, which express somewhat loosely their leading characteristics. But, for the purpose of showing the analogy with physics, we need terms of wider import than those habitually used in politics. All forms of the State imply inter-relationship in the actions of men, and action implies movement. Thus the State may be described as a configuration or arrangement of a community of men; or we may say that it implies a definite mode of motion of man—that is to say, an organised scheme of action of man on man. Political history gives an account of the gradual changes in such configurations or modes of motion of men as have possessed the quality of persistence or of stability to resist the disintegrating influence of surrounding circumstances.

In the world of life the naturalist describes those forms which persist as species; similarly the physicist speaks of stable configurations or modes of motion of matter; and the politician speaks of States. The idea at the base of all these conceptions is that of stability, or the power of resisting disintegration. In other words, the degree of persistence or permanence of a species, of a configuration of matter, or of a State depends on the perfection of its adaptation to its surrounding conditions.

If we trace the history of a State we find the degree of its stability gradually changing, slowly rising to a maximum, and then slowly declining. When it falls to nothing a revolution ensues, and a new form of government is established. The new mode of motion or government has at first but slight stability, but it gradually acquires strength and permanence, until in its turn the slow decay of stability leads on to a new revolution.

Such crises in political history may give rise to a condition in which the State is incapable of perpetuation by transformation. This occurs when a savage tribe nearly exterminates another tribe and leads the few survivors into slavery; the previous form of government then becomes extinct.

The physicist, like the biologist and the historian, watches the effect of slowly varying external conditions; he sees the quality of persistence or stability gradually decaying until it vanishes, when there ensues what is called, in politics, a revolution.

These considerations lead me to express a doubt whether biologists have been correct in looking for continuous transformation of species. Judging by analogy, we should rather expect to find slight continuous changes occurring during a long period of time, followed by a somewhat sudden transformation into a new species, or by rapid extinction. However this may be, when the stability of a mode of motion vanishes, the physicist either finds that it is replaced by a new persistent type of motion adapted to the changed conditions, or perhaps that no such transformation is possible, and that the mode of motion has become extinct. The evanescent type of animal life has often been preserved for us, fossilised in geological strata; the evanescent form of government is preserved in written records or in the customs of savage tribes; but the physicist has to pursue his investigations without such useful hints as to the past.

The time-scale in the transmutation of species of animals is furnished by the geological record, although it is not possible to translate that record into years. As we shall see hereafter, the time needed for a change of type in atoms or molecules may be measured by millionths of a second, while in the history of the stars continuous changes may occupy millions of years. Notwithstanding this gigantic contrast in speed, yet the process involved seems to be essentially the same.

It is hardly too much to assert that, if the conditions which determine stability of motion could be accurately formulated throughout the universe, the past history of the cosmos and its future fate would be unfolded. How indefinitely far we stand removed from such a state of knowledge will become abundantly clear from the remainder of my address.

The study of stability and instability then furnishes the problems which the physicist and biologist alike attempt to solve. The two classes of problems differ principally in the fact that the conditions of the world of life are so incomparably more intricate than those of the world of matter that the biologist is compelled to abandon the attempt to determine the absolute amount of the influence of the various causes which have affected the existence of species. His conclusions are merely qualitative and general, and he is almost universally compelled to refrain from asserting even in general terms what are the reasons which have rendered one form of animal life stable and persistent, and another unstable and evanescent.

On the other hand, the physicist, as a general rule,

[1] "Der Kampf um's Dasein am Himmel." Zweite Auflage. (Berlin: Denicke, 1876.)

does not rest satisfied unless he obtains a quantitative estimate of various causes and effects on the systems of matter which he discusses. Yet there are some problems of physical evolution in which the conditions are so complex that the physicist is driven, as is the biologist, to rest satisfied with qualitative rather than quantitative conclusions. But he is not content with such crude conclusions except in the last resort, and he generally prefers to proceed by a different method.

The mathematician mentally constructs an ideal mechanical system or model, which is intended to represent in its leading features the system he wants to examine. It is often a task of the utmost difficulty to devise such a model, and the investigator may perchance unconsciously drop out as unimportant something which is really essential to represent actuality. He next examines the conditions of his ideal system, and determines, if he can, all the possible stable and unstable configurations, together with the circumstances which will cause transitions from one to the other. Even when the working model has been successfully imagined, this latter task may often overtax the powers of the mathematician. Finally it remains for him to apply his results to actual matter, and to form a judgment of the extent to which it is justifiable to interpret nature by means of his results.

The remainder of my address will be occupied by an account of various investigations which will illustrate the principles and methods which I have now explained in general terms.

The fascinating idea that matter of all kinds has a common substratum is of remote antiquity. In the Middle Ages the alchemists, inspired by this idea, conceived the possibility of transforming the baser metals into gold. The sole difficulty seemed to them the discovery of an appropriate series of chemical operations. We now know that they were always indefinitely far from the goal of their search, yet we must accord to them the honour of having been the pioneers of modern chemistry.

The object of alchemy, as stated in modern language, was to break up or dissociate the atoms of one chemical element into its component parts, and afterwards to reunite them into atoms of gold. Although even the dissociative stage of the alchemistic problem still lies far beyond the power of the chemist, yet modern researches seem to furnish a sufficiently clear idea of the structure of atoms to enable us to see what would have to be done to effect a transformation of elements. Indeed, in the complex changes which are found to occur spontaneously in uranium, radium, and the allied metals we are probably watching a spontaneous dissociation and transmutation of elements.

Natural selection may seem, at first sight, as remote as the poles asunder from the ideas of the alchemist, yet dissociation and transmutation depend on the instability and regained stability of the atom, and the survival of the stable atom depends on the principle of natural selection.

Until some ten years ago the essential diversity of the chemical elements was accepted by the chemist as an ultimate fact, and indeed the very name of atom, or that which cannot be cut, was given to what was supposed to be the final indivisible portion of matter. The chemist thus proceeded in much the same way as the biologist who, in discussing evolution, accepts the species as his working unit. Accordingly, until recently the chemist discussed working models of matter of atomic structure, and the vast edifice of modern chemistry has been built with atomic bricks.

But within the last few years the electrical researches of Lenard, Röntgen, Becquerel, the Curies, of my colleagues Larmor and Thomson, and of a host of others, have shown that the atom is not indivisible, and a flood of light has been thrown thereby on the ultimate constitution of matter. Amongst all these fertile investigators it seems to me that Thomson stands preeminent, because it is principally through him that we are to-day in a better position for picturing the structure of an atom than was ever the case before.

Even if I had the knowledge requisite for a complete exposition of these investigations, the limits of time would compel me to confine myself to those parts of the subject which bear on the constitution and origin of the elements.

It has been shown, then, that the atom, previously supposed to be indivisible, really consists of a large number of component parts. By various convergent lines of experiment it has been proved that the simplest of all atoms, namely that of hydrogen, consists of about 800 separate parts; while the number of parts in the atom of the denser metals must be counted by tens of thousands. These separate parts of the atom have been called corpuscles or electrons, and may be described as particles of negative electricity. It is paradoxical, yet true, that the physicist knows more about these ultra-atomic corpuscles and can more easily count them than is the case with the atoms of which they form the parts.

The corpuscles, being negatively electrified, repel one another just as the hairs on a person's head mutually repel one another when combed with a vulcanite comb. The mechanism is as yet obscure whereby the mutual repulsion of the negative corpuscles is restrained from breaking up the atom, but a positive electrical charge, or something equivalent thereto, must exist in the atom, so as to prevent disruption. The existence in the atom of this community of negative corpuscles is certain, and we know further that they are moving with speeds which may in some cases be comparable to the velocity of light, namely, 200,000 miles a second. But the mechanism whereby they are held together in a group is hypothetical.

It is only just a year ago that Thomson suggested, as representing the atom, a mechanical or electrical model the properties of which could be accurately examined by mathematical methods. He would be the first to admit that his model is at most merely a crude representation of actuality, yet he has been able to show that such an atom must possess mechanical and electrical properties which simulate, with what Whetham describes as "almost Satanic exactness," some of the most obscure and yet most fundamental properties of the chemical elements. "Se non è vero, è ben trovato," and we are surely justified in believing that we have the clue which the alchemists sought in vain.

Thomson's atom consists of a globe charged with positive electricity, inside which there are some thousand or thousands of corpuscles of negative electricity, revolving in regular orbits with great velocities. Since two electrical charges repel one another if they are of the same kind, and attract one another if they are of opposite kinds, the corpuscles mutually repel one another, but all are attracted by the globe containing them. The forces called into play by these electrical interactions are clearly very complicated, and you will not be surprised to learn that Thomson found himself compelled to limit his detailed examination of the model atom to one containing about seventy corpuscles. It is indeed a triumph of mathematical power to have determined the mechanical conditions of such a miniature planetary system as I have described.

It appears that in general there are definite arrangements of the orbits in which the corpuscles must revolve, if they are to be persistent or stable in their motions. But the number of corpuscles in such a community is not absolutely fixed. It is easy to see that we might add a minor planet, or indeed half a dozen minor planets, to the solar system without any material derangement of the whole; but it would not be possible to add a hundred planets with an aggregate mass equal to that of Jupiter without disorganisation of the solar system. So also we might add or subtract from an atom three or four corpuscles from a system containing a thousand corpuscles moving in regular orbits without any profound derangement. As each arrangement of orbits corresponds to the atom of a distinct element, we may say that the addition or subtraction of a few corpuscles to the atom will not effect a transmutation of elements. An atom which has a deficiency of its full complement of corpuscles, which it will be remembered are negative, will be positively electrified, while one with an excess of corpuscles will be negatively electrified. I have referred to the possibility of a deficiency or excess of corpuscles because it is important in Thomson's theory; but, as it is not involved in the point of view which I wish to take, I will henceforth only refer to the normal or average number in any arrange-

ment of corpuscles. Accordingly we may state that definite numbers of corpuscles are capable of association in stable communities of definite types.

An infinite number of communities are possible, possessing greater or lesser degrees of stability. Thus the corpuscles in one such community might make thousands of revolutions in their orbits before instability declared itself; such an atom might perhaps last for a long time as estimated in millionths of seconds, but it must finally break up and the corpuscles must disperse or re-arrange themselves after the ejection of some of their number. We are thus led to conjecture that the several chemical elements represent those different kinds of communities of corpuscles which have proved by their stability to be successful in the struggle for life. If this is so, it is almost impossible to believe that the successful species have existed for all time, and we must hold that they originated under conditions about which I must forbear to follow Sir Norman Lockyer in speculating.[1]

But if the elements were not eternal in the past, we must ask whether there is reason to believe that they will be eternal in the future. Now, although the conception of the decay of an element and its spontaneous transmutation into another element would have seemed absolutely repugnant to the chemist until recently, yet analogy with other moving systems seems to suggest that the elements are not eternal.

At any rate it is of interest to pursue to its end the history of the model atom which has proved to be so successful in imitating the properties of matter. The laws which govern electricity in motion indicate that such an atom must be radiating or losing energy, and therefore a time must come when it will run down, as a clock does. When this time comes it will spontaneously transmute itself into an element which needs less energy than was required in the former state. Thomson conceives that an atom might be constructed after his model so that its decay should be very slow. It might, he thinks, be made to run for a million years, but it would not be eternal.

Such a conclusion is an absolute contradiction to all that was known of the elements until recently, for no symptoms of decay are perceived, and the elements existing in the solar system must already have lasted for millions of years. Nevertheless, there is good reason to believe that in radium, and in other elements possessing very complex atoms, we do actually observe that break-up and spontaneous re-arrangement which constitute a transmutation of elements.

It is impossible as yet to say how science will solve this difficulty, but future discovery in this field must surely prove deeply interesting. It may well be that the train of thought which I have sketched will ultimately profoundly affect the material side of human life, however remote it may now seem from our experiences of daily life.

I have not as yet made any attempt to represent the excessive minuteness of the corpuscles, of the existence of which we are now so confident; but, as an introduction to what I have to speak of next, it is necessary to do so. To obtain any adequate conception of their size we must betake ourselves to a scheme of threefold magnification. Lord Kelvin has shown that, if a drop of water were magnified to the size of the earth, the molecules of water would be of a size intermediate between that of a cricket-ball and of a marble. Now each molecule contains three atoms, two being of hydrogen and one of oxygen. The molecular system probably presents some sort of analogy with that of a triple star; the three atoms, replacing the stars, revolving about one another in some sort of dance which cannot be exactly described. I doubt whether it is possible to say how large a part of the space occupied by the whole molecule is occupied by the atoms; but perhaps the atoms bear to the molecule some such relationship as the molecule to the drop of water referred to. Finally, the corpuscles may stand to the atom in a similar scale of magnitude. Accordingly a threefold magnification would be needed to bring these ultimate parts of the atom within the range of our ordinary scales of measurement.

I have already considered what would be observed under the triply powerful microscope, and must now return to the intermediate stage of magnification, in which we consider those communities of atoms which form molecules. This is the field of research of the chemist. Although prudence would tell me that it would be wiser not to speak of a subject of which I know so little, yet I cannot refrain from saying a few words.

[1] "Inorganic Evolution." (Macmillan, 1900.)

The community of atoms in water has been compared with a triple star, but there are others known to the chemist in which the atoms are to be counted by fifties and hundreds, so that they resemble constellations.

I conceive that here again we meet with conditions similar to those which we have supposed to exist in the atom. Communities of atoms are called chemical combinations, and we know that they possess every degree of stability. The existence of some is so precarious that the chemist in his laboratory can barely retain them for a moment; others are so stubborn that he can barely break them up. In this case dissociation and re-union into new forms of communities are in incessant and spontaneous progress throughout the world. The more persistent or more stable combinations succeed in their struggle for life, and are found in vast quantities, as in the cases of common salt and of the combinations of silicon. But no one has ever found a mine of gun-cotton, because it has so slight a power of resistance. If, through some accidental collocation of elements, a single molecule of gun-cotton were formed, it would have but a short life.

Stability is, further, a property of relationship to surrounding conditions; it denotes adaptation to environment. Thus salt is adapted to the struggle for existence on the earth, but it cannot withstand the severer conditions which exist in the sun.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. A. R. FORSYTH, SC.D., LL.D., MATH.D., F.R.S., PRESIDENT OF THE SECTION.

ACCORDING to an established and unchallenged custom, our proceedings are inaugurated by an address from the President. Let me begin it by discharging a duty which, unhappily, is of regular recurrence. If your President only mentions names when he records the personal losses suffered during the year by the sciences of the Section, the corporate sense of the Section will be able to appreciate the losses with a deeper reality than can be conveyed by mere words.

In Mr. Ronald Hudson, who was one of our secretaries at the Cambridge meeting a year ago, we have lost a mathematician whose youthful promise had ripened into early performance. The original work which he had accomplished is sufficient, both in quality and in amount, to show that much has been given, and that much more could have been expected. His alert and bright personality suggested that many happy years lay before him. All these fair hopes were shattered in a moment by an accident upon a Welsh hillside; and his friends, who were many, deplore his too early death at the age of twenty-eight.

The death of Mr. Frank McClean has robbed astronomy of one of its most patient workers and actively creative investigators. I wish that my own knowledge could enable me to give some not inadequate exposition of his services to the science which he loved so well. He was a man of great generosity which was wise, discriminating, and more than modest; to wide interests in science he united wide interests in the fine arts. Your Astronomer Royal, in the Royal Observatory at Cape Town, will not lightly forget his gift of a great telescope; and the University of Cambridge, the grateful recipient of his munificent endowment of the Isaac Newton Studentships fifteen years ago, and of his no less munificent bequest of manuscripts, early printed books, and objects of art, has done what she can towards perpetuating his memory for future generations by including his name in the list, that is annually recited in solemn service, of her benefactors who have departed this life.

In the early days of our gatherings, when the set of cognate sciences with which we specially are concerned had not yet diverged so widely from one another alike in subject and in method, this inaugurating address was characterised by a brevity that a President can envy and

by a freedom from formality that even the least tolerant audience could find admirable. The lapse of time, perhaps assisted by presidential ambitions which have been veiled under an almost periodic apology for personal shortcomings, has deprived these addresses of their ancient brevity, and has invested them with an air of oracular gravity. The topics vary from year to year, but this variation is due to the predilection of the individual Presidents; the types of address are but few in number. Sometimes, indeed, we have had addresses that cannot be ranged under any comprehensive type. Thus one year we had an account of a particular school of long-sustained consecutive research; another year the President made a constructive (and perhaps defiant) defence of the merits of a group of subjects that were of special interest to himself. But there is one type of address which recurs with iterated frequency; it is constituted by a general account of recent progress in discovery, or by a survey of modern advances in some one or other of the branches of science to which the multiple activities of our Section are devoted. No modern President has attempted a general survey of recent progress in all the branches of our group of sciences; such an attempt will probably be deferred until the Council discovers a President who, endowed with the omniscience of a Whewell, and graced with the tongue of men and of angels, shall once again unify our discussions.

On the basis of this practice, it would have been not unreasonable on my part to have selected some topic from the vast range of pure mathematics, and to have expounded some body of recent investigations. There certainly is no lack of topics; our own day is peculiarly active in many directions. Thus, even if we leave on one side the general progress that has been made in many of the large branches of mathematics during recent years, it is easy to hint at numerous subjects which could occupy the address of a mathematical President. He might, for instance, devote his attention to modern views of continuity, whether of quantity or of space; he might be heterodox or orthodox as to the so-called laws of motion; he might expound his notions as to the nature and properties of analytic functionality; a discussion of the hypotheses upon which a consistent system of geometry can be framed could be made as monumental as his ambition might choose; he could revel in an account of the most recent philosophical analysis of the foundations of mathematics, even of logic itself, in which all axioms must either be proved or be compounded of notions that defy resolution by the human intellect at the present day. Such discussions are bound to be excessively technical unless they are expressed in unmathematical phraseology; when they are so expressed, and in so far as such expression is possible, they become very long and they can be very thin. Moreover, had I chosen any topic of this character, it would have been the merest natural justice to have given early utterance of the sibyllic warning to the uninitiated; I must also have bidden the initiated that, as they come, they should summon all the courage of their souls. So I abstain from making such an experiment upon an unwarned audience; yet it is with reluctance that I have avoided subjects in the range which to me is of peculiar interest.

On the other hand, I must ask your indulgence for not conforming to average practice and expectation. My desire is to mark the present occasion by an address of unspecialised type which, while it is bound to be mainly mathematical in tenor, and while it will contain no new information, may do little more than recall some facts that are known, and will comment briefly upon obvious tendencies. Let me beg you to believe that it is no straining after novelty which has dictated my choice; such an ambition has a hateful facility of being fatal both to the performer and to the purpose. It is the strangeness of our circumstances, both in place and time, that has suggested my subject. With an adventurous audacity that quite overcrows the spirit of any of its past enterprises, the British Association for the Advancement of Science has travelled south of the Equator and, in accepting your hospitality, proposes to traverse much of South Africa. The prophet of old declared that "many shall run to and fro, and knowledge shall be increased"; if the second part of the prophecy is not fulfilled, it will not be for the want of our efforts to fulfil the first part. And if the place and the range of this peripatetic demonstration of our annual corporate activity are unusual, the occasion chosen for this enterprise recalls memories that are fundamental in relation to our subject. It is a modern fashion to observe centenaries. In this section we are in the unusual position of being able to observe three scientific centenaries in one and the same year. Accordingly I propose to refer to these in turn, and to indicate a few of the events filling the intervals between them; but my outline can be of only the most summary character, for the scientific history is a history of three hundred years, and, if searching enough, it could include the tale of nearly all mathematical and astronomical and physical science.

It is exactly three hundred years since Bacon published "The Advancement of Learning." His discourse, alike in matter, in thought, in outlook, was in advance of its time, and it exercised no great influence for the years that immediately followed its appearance; yet that appearance is one of the chief events in the origins of modern natural science. Taking all knowledge to be his province, he surveys the whole of learning: he deals with the discredits that then could attach to it; he expounds both the dignity and the influence of its pursuit; and he analyses all learning, whether of things divine or of things human, into its ordered branches. He points out deficiencies and gaps; not a few of his recommendations of studies, at his day remaining untouched, have since become great branches of human thought and human inquiry. But what concerns us most here is his attitude towards natural philosophy, all the more remarkable because of the state of knowledge of that subject in his day, particularly in England. It is true that Gilbert had published his discovery of terrestrial magnetism some five years earlier, a discovery followed only too soon by his death; but that was the single considerable English achievement in modern science down to Bacon's day.

In order to estimate the significance of Bacon's range of thought let me recite a few facts, as an indication of the extreme tenuity of progressive science in that year (1605). They belong to subsequent years, and may serve to show how restricted were the attainments of the period, and how limited were the means of advance. The telescope and the microscope had not yet been invented. The simple laws of planetary motion were not formulated, for Kepler had them only in the making. Logarithms were yet to be discovered by Napier, and to be calculated by Briggs. Descartes was a boy of nine and Fermat a boy of only four, so that analytical geometry, the middle-life discovery of both of them, was not yet even a dream for either of them. The Italian mathematicians, of whom Cavalieri is the least forgotten, were developing Greek methods of quadrature by a transformed principle of indivisibles; but the infinitesimal calculus was not really in sight, for Newton and Leibnitz were yet unborn. Years were to elapse before, by the ecclesiastical tyranny over thought, Galileo was forced to make a verbal disavowal of his adhesion to the Copernican system of astronomy, of which he was still to be the protagonist in propounding any reasoned proof. Some mathematics could be had, cumbrous arithmetic and algebra, some geometry lumbering after Euclid, and a little trigonometry; but these were mainly the mathematics of the Renaissance, no very great advance upon the translated work of the Greeks and the transmitted work of the Arabs. Even our old friend the binomial theorem, which now is supposed to be the possession of nearly every able schoolboy, remained unknown to professional mathematicians for more than half a century yet to come.

Nor is it merely on the negative side that the times seemed unpropitious for a new departure; the spirit of the age in the positive activities of thought and deed was not more sympathetic. Those were the days when the applications of astronomy had become astrology. Men sought for the elixir of life and pondered over the transmutation of baser metals into gold. Shakespeare not long before had produced his play *As You Like It*, where the strange natural history of the toad which,

> "Ugly and venomous,
> Bears yet a precious jewel in his head."

is made a metaphor to illustrate the sweetening uses of adversity. The stiffened Elizabethan laws against witch-

craft were to be sternly administered for many a year to come. It was an age that was pulsating with life and illuminated by fancy, but the life was the life of strong action and the fancy was the fancy of ideal imagination; men did not lend themselves to sustained and abstract thought concerning the nature of the universe. When we contemplate the spirit that such a state of knowledge might foster towards scientific learning, and when we recall the world into which Bacon's treatise was launched, we can well be surprised at his far-reaching views, and we can marvel at his isolated wisdom.

Let me select a few specimens of his judgments, chosen solely in relation to our own subjects. When he says:

"All true and fruitful natural philosophy hath a double scale or ladder, ascendant and descendant, ascending from experiments to the invention of causes, and descending from causes to the invention of new experiments; therefore I judge it most requisite that these two parts be severally considered and handled"—

he is merely expounding, in what now is rather archaic phrase, the principles of the most ambitious investigations in the natural philosophy of subsequent centuries. When he speaks of

"the operation of the relative and adventive characters of essences, as quantity, similitude, diversity, possibility, and the rest; with this distinction and provision, that they be handled as they have efficacy in nature, and not logically"—

I seem to hear the voice of the applied mathematician warning the pure mathematician off the field. When, after having divided natural philosophy into physic and metaphysic (using these words in particular meanings, and including mathematics in the second of the divisions), he declares

"physic should contemplate that which is inherent in matter, and therefore transitory, and metaphysic that which is abstracted and fixed; . . . physic describeth the causes of things, but the variable or respective causes; and metaphysic the fixed and constant causes"—

there comes before my mind the army of physicists of the present day, who devote themselves unwearyingly to the properties of matter and willingly cast aside elaborate arguments and calculations. When he argues that

"many parts of nature can neither be invented with sufficient subtilty, nor demonstrated with sufficient perspicuity, nor accommodated unto use with sufficient dexterity, without the aid and intervening of the mathematics"—

he might be describing the activity of subsequent generations of philosophers, astronomers, and engineers. And in the last place (for my extracts must have some end), when he expresses the opinion

"that men do not sufficiently understand the excellent use of the pure mathematics, in that they do remedy and cure many defects in the wit and faculties intellectual. For if the wit be too dull, they sharpen it; if too wandering, they fix it; if too inherent in the sense, they abstract it; . . ., in the mathematics, that which is collateral and intervenient is no less worthy than that which is principal and intended"—

I seem to hear an advocate for the inclusion of elementary mathematics in any scheme of general education. At the same time, I wonder what Bacon, who held such an exalted estimate of pure mathematics in its grey dawn, would have said by way of ampler praise of the subject in its fuller day.

It was a splendid vision of inductive science as of other parts of learning; it contained a revelation of the course of progress through the centuries to come. Yet the facts of to-day are vaster than the vision of that long-ago yesterday, and human activity has far outstripped the dreams of Bacon's opulent imagination. He was the harbinger (premature in many respects it must be confessed, but still the harbinger) of a new era. At a time when we are making a new departure in the fulfilment of the purpose of our charter, which requires us "to promote the intercourse of those who cultivate Science in different parts of the British Empire," our Association for the Advancement of Science may pause for a moment to gaze upon the vision revealed three centuries ago in the "Advancement of Learning" by a philosopher whose influence upon the thought of the world is one of the glories of our nation.

I have implied that Bacon's discourse was in advance of its age, so far as England was concerned. Individuals could make their mark in isolated fashion. Thus Harvey, in his hospital work in London, discovered the circulation of the blood; Napier, away on his Scottish estates, invented logarithms; and Horrocks, in the seclusion of a Lancashire curacy, was the first to observe a transit of Venus. But for more than half a century the growth of physical science was mainly due to workers on the continent of Europe. Galileo was making discoveries in the mechanics of solids and fluids, and, specially, he was building on a firm foundation the fabric of the system of astronomy, hazarded nearly a century before by Copernicus; he still was to furnish, by bitter experience, one of the most striking examples in the history of the world that truth is stronger than dogma. Kepler was gradually elucidating the laws of planetary motion, of which such significant use was made later by Newton; and Descartes, by his creation of analytical geometry, was yet to effect such a constructive revolution in mathematics that he might not unfairly be called the founder of modern mathematics. In England the times were out of scientific joint; the political distractions of the Stuart troubles, and the narrow theological bitterness of the Commonwealth, made a poor atmosphere for the progress of scientific learning, which was confined almost to a faithful few. The fidelity of those few, however, had its reward; it was owing to their steady confidence and to their initiative that the Royal Society of London was founded in 1662 by Charles II. At that epoch, science (to quote the words of a picturesque historian) became the fashion of the day. Great Britain began to contribute at least her fitting share to the growing knowledge of Nature; and her scientific activity in the closing part of the seventeenth century was a realisation, wonderful and practical, of a part of Bacon's dream. Undoubtedly the most striking contribution made in that period is Newton's theory of gravitation, as expounded in his "Principia," published in 1687.

That century also saw the discovery of the fluxional calculus by Newton, and of the differential calculus by Leibnitz. These discoveries provided the material for one of the longest and most deadening controversies as to priority in all the long history of those tediously barren occupations; unfortunately they are dear to minds which cannot understand that a discovery should be used, developed, amplified, but should not be a cause of envy, quarrel, or controversy. Let me say, incidentally, that the controversy had a malign influence upon the study of mathematics as pursued in England.

Also, the undulatory theory of light found its first systematic, if incomplete, exposition in the work of Huygens before the century was out. But Newton had an emission theory of his own, and so the undulatory theory of Huygens found no favour in England until rather more than a hundred years later; the researches of Thomas Young established it on a firm foundation.

Having thus noted some part of the stir in scientific life which marked the late years of the seventeenth century, let me pass to the second of our centenaries; it belongs to the name of Edmond Halley. Quite independently of his achievement connected with the year 1705 to which I am about to refer, there are special reasons for honouring Halley's name in this section at our meeting in South Africa. When a young man of twenty-one he left England for St. Helena, and there, in the years 1676–1678, he laid the foundations of stellar astronomy for the Southern Hemisphere; moreover, in the course of his work he there succeeded in securing the first complete observation of a transit of Mercury. After his return to England, the next few years of his life were spent in laying science under a special debt that can hardly be over-appreciated. He placed himself in personal relation with Newton, propounded to him questions and offered information; and it is now a commonplace statement that Halley's questions and suggestions caused Newton to write the "Principia."

More than this, we know that Newton's great treatise saw the light only through Halley's persuasive insistence, through his unwearying diligence in saving Newton all cares and trouble and even pecuniary expense, and through his absolutely self-sacrificing devotion to what he made an unwavering duty at that epoch in his life. Again, he appears to have been the first organiser of a scientific expedition, as distinct from a journey of discovery, towards the Southern Seas; he sailed as far as the fifty-second degree of southern latitude, devised the principle of the sextant in the course of his voyaging, and, as a result of the voyage, he produced a General Chart of the Atlantic Ocean, with special reference to the deviation of the compass. Original, touched with genius, cheery of soul, strenuous in thought and generous by nature, he spent his life in a continuously productive devotion to astronomical science, from boyhood to a span of years far beyond that which satisfied the Psalmist's broodings. I have selected a characteristic incident in his scientific activity, one of the most brilliant (though it cannot be claimed as the most important) of his astronomical achievements; it strikes me as one of the most chivalrously bold acts of convinced science within my knowledge. It is only the story of a comet.

I have just explained, very briefly, Halley's share in the production of Newton's "Principia"; his close concern with it made him the Mahomet of the new dispensation of the astronomical universe, and he was prepared to view all its phenomena in the light of that dispensation. A comet had appeared in 1682—it was still the age when scientific men could think that, by a collision between the earth and a comet, "this most beautiful order of things would be entirely destroyed and reduced to its ancient chaos"; but this fear was taken as a "by-the-bye," which happily interfered with neither observations nor calculations. Observations had duly been made. The data were used to obtain the elements of the orbit, employing Newton's theory as a working hypothesis; and he expresses an incidental regret as to the intrinsic errors of assumed numerical elements and of recorded observations. It then occurred to Halley to calculate similarly the elements of the comet which Kepler and others had seen in 1607, and of which records had been made; the Newtonian theory gave elements in close accord with those belonging to the comet calculated from the latest observations, though a new regret is expressed that the 1607 observations had not been made with more accuracy. On these results he committed himself (being then a man of forty-nine years of age) to a prophecy (which could not be checked for fifty-three years to come) that the comet would return about the end of the year 1758 or the beginning of the next succeeding year; he was willing to leave his conclusion "to be discussed by the care of posterity, after the truth is found out by the event." But not completely content with this stage of his work, he obtained with difficulty a book by Apian, giving an account of a comet seen in 1531 and recording a number of observations. Halley, constant to his faith in the Newtonian hypothesis, used that hypothesis to calculate the elements of the orbit of the Apian comet; once more regretting the uncertainty of the data and discounting a very grievous error committed by Apian himself, Halley concluded that the Apian comet of 1531, and the Kepler comet of 1607, and the observed comet of 1682 were one and the same. He confirmed his prediction as to the date of its return, and he concludes his argument with a blend of confidence and patriotism:—

"Wherefore if according to what we have already said it should return again about the year 1758, candid posterity will not refuse to acknowledge that this was first discovered by an *Englishman.*"

Such was Halley's prediction published in the year 1705. The comet pursued its course, and it was next seen on Christmas Day, 1758. Candid posterity, so far from refusing to acknowledge that the discovery was made by an Englishman, has linked Halley's name with the comet, possibly for all time.

We all now could make announcements on the subject of Halley's comet; their fulfilment could be awaited serenely. No vision or inspiration is needed; calculations and corrections will suffice. The comet was seen in 1835, and it is expected again in 1910. No doubt our astronomers will be ready for it; and the added knowledge of electrical science, in connection particularly with the properties of matter, may enable them to review Bessel's often-discussed conjecture as to an explanation of the emission of a sunward tail. But Halley's announcement was made during what may be called the immaturity of the gravitation theory; the realisation of the prediction did much to strengthen the belief in the theory and to spread its general acceptance; the crown of conviction was attained with the work of Adams and Leverrier in the discovery, propounded by theory and verified by observation, of the planet Neptune. I do not know an apter illustration of Bacon's dictum that has already been quoted, "All true and fruitful natural philosophy hath a double scale, ascending from experiments to the invention of causes, and descending from causes to the invention of new experiments." The double process, when it can be carried out, is one of the most effective agents for the increase of trustworthy knowledge. But until the event justified Halley's prediction, the Cartesian vortex-theory of the universe was not completely replaced by the Newtonian theory; the Cartesian votaries were not at once prepared to obey Halley's jubilant, if stern, injunction to "leave off trifling . . . with their vortices and their absolute plenum . . . and give themselves up to the study of truth."

The century that followed the publication of Halley's prediction shows a world that is steadily engaged in the development of the inductive sciences and their applications. Observational astronomy continued its activity quite steadily, reinforced towards the end of the century by the first of the Herschels. The science of mathematical (or theoretical) astronomy was created in a form that is used to this day; but before this creation could be effected, there had to be a development of mathematics suitable for the purpose. The beginnings were made by the Bernoullis (a family that must be of supreme interest to Dr. Francis Galton in his latest statistical compilations, for it contained no fewer than seven mathematicians of mark, distributed over three generations), but the main achievements are due to Euler, Lagrange, and Laplace. In particular, the infinitesimal calculus in its various branches (including, that is to say, what we call the differential calculus, the integral calculus, and differential equations) received the development that now is familiar to all who have occasion to work in the subject. When this calculus was developed, it was applied to a variety of subjects; the applications, indeed, not merely influenced, but immediately directed, the development of the mathematics. To this period is due the construction of analytical mechanics at the hands of Euler, d'Alembert, Lagrange, and Poisson; but the most significant achievement in this range of thought is the mathematical development of the Newtonian theory of gravitation applied to the whole universe. It was made, in the main, by Lagrange, as regards the wider theory, and by Laplace, as regards the amplitude of detailed application. But it was a century that also saw the obliteration of the ancient doctrines of caloric and phlogiston, through the discoveries of Rumford and Davy of the nature and relations of heat. The modern science of vibrations had its beginnings in the experiments of Chladni, and, as has already been stated, the undulatory theory of light was rehabilitated by the researches of Thomas Young. Strange views as to the physical constitution of the universe then were sent to the limbo of forgotten ignorance by the early discoveries of modern chemistry; and engineering assumed a systematic and scientific activity, the limits of which seem bounded only by the cumulative ingenuity of successive generations. But in thus attempting to summarise the progress of science in that period, I appear to be trespassing upon the domains of other Sections; my steps had better be retraced so as to let us return to our own upper air. If I mention one more fact (and it will be a small one), it is because of its special connection with the work of this Section. As you are aware, the elements of Euclid have long been the standard treatise of elementary geometry in Great Britain; and the Greek methods, in Robert Simson's edition, have been imposed upon candidates in examination after ex-

amination. But Euclid is on the verge of being disestablished; my own University of Cambridge, which has had its full share in maintaining the restriction to Euclid's methods, and which was not uninfluenced by the report of a Committee of this Association upon the subject, will, some six or seven weeks hence, hold its last examination in which those methods are prescriptively required. The disestablishment of Euclid from tyranny over the youthful student on the continent of Europe was effected before the end of the eighteenth century.

But it is time for me to pass on to the third of the centenaries, with which the present year can be associated. Not so fundamental for the initiation of modern science as was the year in which the "Advancement of Learning" was published, not so romantic in the progress of modern science as was the year in which Halley gave his prediction to the world, the year 1805 (turbulent as it was with the strife of European politics) is marked by the silent voices of a couple of scientific records. In that year Laplace published the last progressive instalment of his great treatise on Celestial Mechanics, the portion that still remained for the future being solely of an historical character; the great number of astronomical phenomena which he had been able to explain by his mathematical presentation of the consequences of the Newtonian theory would, by themselves, have been sufficient to give confidence in the validity of that theory. In that year also Monge published his treatise, classical and still to be read by all students of the subject, "The Application of Algebra to Geometry"; it is the starting point of modern synthetic geometry, which has marched in ample development since his day. These are but landmarks in the history of mathematical science, one of them indicating the completed attainment of a tremendous task, the other of them initiating a new departure; both of them have their significance in the progress of their respective sciences.

When we contemplate the activity and the achievements of the century that has elapsed since the stages which have just been mentioned were attained in mathematical science, the amount, the variety, the progressive diligence, are little less than bewildering. It is not merely the vast development of all the sciences that calls for remark; no less striking is their detailed development. Each branch of science now has an enormous array of workers, a development rendered more easily possible by the growing increase in the number of professional posts; and through the influence of these workers and their labours there is an ever-increasing body of scientific facts. Yet an aggregate of facts is not an explanatory theory any more necessarily than a pile of carefully fashioned stones is a cathedral; and the genius of a Kepler and a Newton is just as absolutely needed to evolve the comprehending theory as the genius of great architects was needed for the Gothic cathedrals of France and of England. Not infrequently it is difficult to make out what is the main line of progress in any one subject, let alone in a group of subjects; and though illumination comes from striking results that appeal, not merely to the professional workers, but also to unprofessional observers, this illumination is the exception rather than the rule. We can allow, and we should continue to allow, freedom of initiative in all directions. That freedom sometimes means isolation, and its undue exercise can lead to narrowness of view. In spite of the complex ramification of the sciences which it has fostered, it is a safer and a wiser spirit than that of uncongenial compulsion, which can be as dogmatic in matters scientific as it can be in matters theological. Owing to the varieties of mind, whether in individuals or in races, the progress of thought and the growth of knowledge are not ultimately governed by the wishes of any individual or the prejudices of any section of individuals. Here, a school of growing thought may be ignored; there, it may be denounced as of no importance; somewhere else, it may be politely persecuted out of possible existence. But the here, and the there, and the somewhere else do not make up the universe of human activity; and that school, like Galileo's earth in defiance of all dogmatic authority, still will move.

This complete freedom in the development of scientific thought, when the thought is applied to natural phenomena, is all the more necessary because of the ways of Nature. Physical nature cares nothing for theories, nothing for calculations, nothing for difficulties, whatever their source; she will only give facts in answer to our questions, without reasons and without explanations; we may explain as we please and evolve laws as we like, without her help or her hindrance. If from our explanations and our laws we proceed to prediction, and if the event justifies the prediction through agreement with recorded fact, well and good; so far we have a working hypothesis. The significance of working hypotheses, in respect of their validity and their relation to causes, is a well known battle-ground of dispute between different schools of philosophers; it need not detain us here and now. On the other hand, when we proceed from our explanations and our laws to a prediction, and the prediction in the end does not agree with the fact to be recorded, it is the prediction that has to give way. But the old facts remain and the new fact is added to them; and so facts grow until some working law can be extracted from them. This accumulation of facts is only one process in the solution of the universe; when the compelling genius is not at hand to transform knowledge into wisdom, useful work can still be done upon them by the construction of organised accounts which shall give a systematic exposition of the results, and shall place them as far as may be in relative significance.

Let me pass from these generalities, which have been suggested to my mind by the consideration of some of the scientific changes that have taken place during the last hundred years, and let me refer briefly to some of the changes and advances which appear to me to be most characteristic of that period. It is not that I am concerned with a selection of the most important researches of the period. Estimates of relative importance are often little more than half-concealed expressions of individual preferences or personal enthusiasms; and though each enthusiastic worker, if quite frank in expressing his opinion, would declare his own subject to be of supreme importance, he would agree to a compromise that the divergence between the different subjects is now so wide as to have destroyed any common measure of comparison. My concern is rather with changes, and with tendencies where these can be discerned.

The growth of astronomy has already occupied so large a share of my remarks that few more words can be spared here. Not less, but more, remarkable than the preceding centuries in the actual exploration of the heavens, which has been facilitated so much by the improvements in instruments and is reinforced to such effect by the cooperation of an ever-growing band of American astronomers, it has seen a new astronomy occupy regions undreamt of in the older days. New methods have supplemented the old; spectroscopy has developed a science of physics within astronomy; and the unastronomical brain reels at the contents of the photographic chart of the heavens which is now being constructed by international cooperation and will, when completed, attempt to map ten million stars (more or less) for the human eye.

Nor has the progress of physics, alike on the mathematical side and the experimental side, been less remarkable or more restricted than that of astronomy. The elaborate and occasionally fantastic theories of the eighteenth century, in such subjects as light, heat, even as to matter itself, were rejected in favour of simpler and more comprehensive theories. There was one stage when it seemed as if the mathematical physicists were gradually overtaking the experimental physicists; but the discoveries in electricity begun by Faraday left the mathematicians far behind. Much has been done towards the old duty, ever insistent, of explaining new phenomena; and the names of Maxwell, Weber, Neumann, and Hertz need only to be mentioned in order to suggest the progress that has been made in one subject alone. We need not hesitate to let our thoughts couple, with the great physicists of the century, the leaders of that brilliant band of workers upon the properties of matter who carry us on from wonder to wonder with the passage of each successive year.

Further, it has been an age when technical applications have marched at a marvellous pace. So great has been their growth that we are apt to forget their comparative youth; yet it was only the middle of the century which

saw the awakening from what now might be regarded as the dark ages. Nor is the field of possible application nearing exhaustion; on the contrary, it seems to be increasing by reason of new discoveries in pure science that yet will find some beneficent outcome in practice. Invisible rays and wireless telegraphy may be cited as instances that are occupying present activities, not to speak of radium, the unfolding of the future of which is watched by eager minds.

One gap, indeed, in this subject strikes me. There are great histories of mathematics and great histories of astronomy; I can find no history of physics on the grand scale. Some serviceable manuals there are, as well as monographs on particular topics; what seems to me to be lacking is some comprehensive and comparative survey of the whole range. The history of any of the natural sciences, like the history of human activity, is not merely an encyclopædic record of past facts; it reveals both the spirit and the wealth which the past has bequeathed to the present, and which, in due course, the present will influence before transmission to the future. Perhaps all our physicists are too busy to spare the labour needed for the production of a comprehensive history; yet I cannot help thinking that such a contribution to the subject would be of great value, not to physicists alone.

But, as you hear me thus referring to astronomy and to physics, some of you may think of the old Roman proverb which bade the cobbler not to look above his last; so I take the opportunity of referring very briefly to my own subject. One of the features of the century has been the continued development of mathematics. As a means of calculation the subject was developed as widely during the earlier portion of the century as during the preceding century; it soon began to show signs of emergence as an independent science, and the later part of the century has witnessed the emancipation of pure mathematics. It was pointed out, in connection with the growth of theoretical astronomy, that mathematics developed in the direction of its application to that subject. When the wonderful school of French physicists, composed of Monge, Carnot, Fourier, Poisson, Poinsot, Ampère, and Fresnel (to mention only some names), together with Gauss, Kirchhoff, and von Helmholtz in Germany, and Ivory, Green, Stokes, Maxwell, and others in England, applied their mathematics to various branches of physics, for the most part its development was that of an ancillary subject. The result is the superb body of knowledge that may be summarised under the title of "mathematical physics"; but the final interest is the interest of physics, though the construction has been the service of mathematics. Moreover, this tendency was deliberate, and was avowed in no uncertain tone. Thus Fourier could praise the utility of mathematics by declaring that "there was no language more universal or simpler, more free from errors or obscurity, more worthy of expressing the unchanging relations of natural entities"; in a burst of enthusiasm he declares that, from the point of view he had indicated, "mathematical analysis is as wide as Nature herself," and "it increases and grows incessantly stronger amid all the changes and errors of the human mind." Mathematicians might almost blush with conscious pleasure at such a laudation of their subject from such a quarter, though it errs both by excess and defect; but the exultation of spirit need not last long. The same authority, when officially expounding to the French Academy the work of Jacobi and of Abel upon elliptic functions, expressed his chilling opinion (it had nothing to do with the case) that "the questions of natural philosophy, which have the mathematical study of all important phenomena for their aim, are also a worthy and principal subject for the meditations of geometers. It is to be desired that those persons who are best fitted to improve the science of calculation should direct their labours to these important applications." Abel was soon to pass beyond the range of admonition; but Jacobi, in a private letter to Legendre, protested that the scope of the science was not to be limited to the explanation of natural phenomena. I have not quoted these extracts by way of even hint of reproach against the author of such a wonderful creation as Fourier's analytical theory of heat; his estimate could have been justified on a merely historical review of the circumstances of his own time and of past times; and I am not sure that his estimate has not its exponents at the present day. But all history shows that new discoveries and new methods can spread to issues wider than those of their origins, and that it is almost a duty of human intelligence to recognise this possibility in the domain of progressive studies. The fact is that mathematical physics and pure mathematics have given much to each other in the past and will give much to each other in the future; in doing so, they will take harmonised action in furthering the progress of knowledge. But neither science must pretend to absorb the activity of the other. It is almost an irony of circumstance that a theorem, initiated by Fourier in the treatise just mentioned, has given rise to a vast amount of discussion and attention, which, while of supreme value in the development of one branch of pure mathematics, have hitherto offered little, if anything, by way of added explanation of natural phenomena.

The century that has gone has witnessed a wonderful development of pure mathematics. The bead-roll of names in that science—Gauss; Abel, Jacobi; Cauchy, Riemann, Weierstrass, Hermite; Cayley, Sylvester; Lobatchewsky, Lie—will on only the merest recollection of the work with which their names are associated show that an age has been reached where the development of human thought is deemed as worthy a scientific occupation of the human mind as the most profound study of the phenomena of the material universe.

The last feature of the century that will be mentioned has been the increase in the number of subjects, apparently dissimilar from one another, which are now being made to use mathematics to some extent. Perhaps the most surprising is the application of mathematics to the domain of pure thought; this was effected by George Boole in his treatise "Laws of Thought," published in 1854; and though the developments have passed considerably beyond Boole's researches, his work is one of those classics that mark a new departure. Political economy, on the initiative of Cournot and Jevons, has begun to employ symbols and to develop the graphical methods; but, there, the present use seems to be one of suggestive record and expression, rather than of positive construction. Chemistry, in a modern spirit, is stretching out into mathematical theories; Willard Gibbs, in his memoir on the equilibrium of chemical systems, has led the way; and, though his way is a path which chemists find strewn with the thorns of analysis, his work has rendered, incidentally, a real service in coordinating experimental results belonging to physics and to chemistry. A new and generalised theory of statistics is being constructed; and a school has grown up which is applying them to biological phenomena. Its activity, however, has not yet met with the sympathetic goodwill of all the pure biologists; and those who remember the quality of the discussion that took place last year at Cambridge between the biometricians and some of the biologists will agree that, if the new school should languish, it will not be for want of the tonic of criticism.

If I have dealt with the past history of some of the sciences with which our Section is concerned, and have chosen particular epochs in that history with the aim of concentrating your attention upon them, you will hardly expect me to plunge into the future. Being neither a prophet nor the son of a prophet, not being possessed of the knowledge which enabled Halley to don the prophet's mantle with confidence, I shall venture upon no prophecy even so cautious as Bacon's—"As for the mixed mathematics I may only make this prediction, that there cannot fail to be more kinds of them as Nature grows further disclosed"—a declaration that is sage enough, though a trifle lacking in precision. Prophecy, unless based upon confident knowledge, has passed out of vogue, except perhaps in controversial politics; even in that domain, it is helpless to secure its own fulfilment. Let me rather exercise the privilege of one who is not entirely unfamiliar with the practice of geometry, and let me draw the proverbial line before indulgence in prophetic estimates. The names that have flitted through my remarks, the discoveries and the places associated with those names, definitely indicate that, notwithstanding all appearance of

divergence and in spite of scattered isolation, the sum of human knowledge, which is an inheritance common to us all, grows silently, sometimes slowly, yet (as we hope) safely and surely, through the ages. You who are in South Africa have made an honourable and an honoured contribution to that growing knowledge, conspicuously in your astronomy and through a brilliant succession of astronomers. Here, not as an individual but as a representative officer of our brotherhood in the British Association, I can offer you no better wish than that you may produce some men of genius and a multitude of able workers who, by their researches in our sciences, may add to the fame of your country and will contribute to the intellectual progress of the world.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY G. T. BEILBY, PRESIDENT OF THE SECTION.

IN scanning the list of the elements with which we are thoughtfully supplied every year by the International Committee on Atomic Weights, the direction in which our thoughts are led will depend on the particular aspect of chemical study which happens to interest us at the time. Putting from our minds on the present occasion the attractive speculations on atomic constitution and disintegration with which we have all become at least superficially familiar during the past few years, let us try to scan this list from the point of view of the "plain man" rather than from that of the expert chemist. Even a rudimentary knowledge will be sufficient to enable our "plain man" to divide the elements broadly into two groups—the actually useful and the doubtfully useful or useless. Without going into detail we may take it that about two-thirds would be admitted into the first group, and one-third into the second. It must, I think, be regarded as a very remarkable fact that of the eighty elements which have had the intrinsic stability to enable them to survive the prodigious forces which must have been concerned in the evolution of the physical universe, so large a proportion are endowed with characteristic properties which could ill have been spared either from the laboratories of Nature or from those of the Arts and Sciences. Even if one-third of the elements are to be regarded as waste products or failures, there is here no counterpart to the reckless prodigality of Nature in the processes of organic evolution.

If we exclude those elements which participate directly and indirectly in the structure and functions of the organic world, there are two elements which stand out conspicuously because of the supreme influence they have exercised over the trend of human effort and ambition. I refer, of course, to the metals gold and iron.

From the early beginnings of civilisation gold has been highly prized and eagerly sought after. Human life has been freely sacrificed in its acquirement from natural sources, as well as in its forcible seizure from those who already possessed it. The "Age of Gold" was not necessarily "The Golden Age," for the noble metal in its unique and barbaric splendour has symbolised much that has been unworthy in national and individual aims and ideals.

We have accustomed ourselves to think of the present as the Age of Iron, as indeed it is, for we see in the dull, grey metal the plastic medium out of which the engineer has modelled the machines and structures which play so large a part in the active life of to-day. Had iron not been at once plentiful and cheap, had it not brought into the hands of the engineer and artificer its marvellous qualities of hardness and softness, of rigidity and toughness, and to the electrician its mysterious and unique magnetic qualities, it is not difficult to conceive that man's control over the forces of Nature might have been delayed for centuries, or perhaps for ages. For iron has been man's chief material instrument in the conquest of Nature; without it the energy alike of the waterfall and of the coalfield would have remained uncontrolled and unused. In this conquest of the resources of Nature for the service of man are we not entitled to say that the intellectual and social gains have equalled, if they have not exceeded, in value the purely material gains; and may we not then regard iron as the symbol of a beneficent conquest of Nature?

With the advent of the Industrial Age gold was destined to take a new place in the world's history as the great medium of exchange, the great promoter of industry and commerce. While individual gain still remained the propelling power towards its discovery and acquisition, every fresh discovery led directly or indirectly to the freer interchange of the products of industry, and thus reacted favourably on the industrial and social conditions of the time.

So long as the chief supplies of gold were obtained from alluvial deposits by the simple process of washing, the winning of gold almost necessarily continued to be pursued by individuals, or by small groups of workers, who were mainly attracted by the highly speculative nature of the occupation. These workers endured the greatest hardships and ran the most serious personal risks, drawn on from day to day by the hope that some special stroke of good fortune would be theirs. This condition prevailed also in fields in which the reef gold occurred near the surface, where it was easily accessible without costly mining appliances, and where the precious metal was loosely associated with a weathered matrix. These free-milling ores could be readily handled by crushing and amalgamation with mercury, so that here also no elaborate organisation and no great expenditure of capital were necessary. A third stage was reached when the more easily worked deposits above the water-line had been worked out. Not only were more costly appliances and more elaborately organised efforts required to bring the ore to the surface, but the ore when obtained contained less of its gold in the easily recovered, and more in the refractory or combined form. The problem of recovery had now to be attacked by improved mechanical and chemical methods. The sulphides or tellurides with which the gold was associated or combined had to be reduced to a state of minute subdivision by more perfect stamping or grinding, and elaborate precautions were necessary to ensure metallic contact between the particles of gold and the solvent mercury. In many cases the amalgamation process failed to extract more than a very moderate proportion of the gold, and the quartz sand or "tailings" which still contained the remainder found its way into creeks and rivers or remained in heaps on the ground around the batteries. In neighbourhoods where fuel was available a preliminary roasting of the ore was resorted to, to oxidise or volatilise the baser metals and set free the gold; or the sulphides, tellurides, &c., were concentrated by washing, and the concentrates were taken to smelting or chlorinating works in some favourable situation where the more elaborate metallurgical methods could be economically applied. Many efforts were also made to apply the solvent action of chlorine directly to the unconcentrated unroasted ores; but unfortunately chlorine is an excellent solvent for other substances besides gold, and in practice it was found that its solvent energy was mainly exercised on the base metals and metalloids, and on the materials of which the apparatus itself was constructed.

This to the best of my knowledge is a correct, if rather sketchy, description of the state of matters in 1889 when the use of a dilute solution of cyanide of potassium was first seriously proposed for the extraction of gold from its ores. Those of us who can recall the time will remember that the proposal was far from favourably regarded from a chemical point of view. The cost of the reagent, its extremely poisonous nature, the instability of its solutions, its slow action—such were the difficulties that naturally presented themselves to our minds. And, even granting that these difficulties might be overcome, there still remained the serious problem of how to recover the gold in metallic form from the extremely dilute solutions of the cyanide of gold and potassium. How each and all of these difficulties have been swept aside, how within little more than a decade this method of gold extraction has spread over the gold-producing countries of the world, now absorbing and now replacing the older processes, but ever carrying all before it—all this is already a twice-told tale which I should feel hardly justified in

alluding to were it not for the fact that we are to-day meeting on the Rand where the infant process made its *début* nearly fourteen years ago. The Rand to-day is the richest of the world's goldfields, not only in its present capacity, but in its potentialities for the future; twenty years ago its wonderful possibilities were quite unsuspected even by experts.

It is not for me to describe in detail how the change has been accomplished; this task will, we know, be far better accomplished by representative chemists who are now actively engaged in the work. But for the chemists of the British Association it is a fact of great significance that they are here in the presence of the most truly industrial development of gold production which the world has yet seen; a development moreover that is founded on a purely chemical process which for its continuance requires, not only skilled chemists to superintend its operation, but equally skilled chemists to supply the reagent on which the industry depends.

In 1889 the world's consumption of cyanide of potassium did not exceed fifty tons per annum. This was produced by melting ferrocyanide with carbonate of potassium, the clear fused cyanide so obtained being decanted from the carbide of iron which had separated. The resulting salt was a mixture of cyanide, cyanate, and carbonate which was sometimes called cyanide of potassium for the hardly sufficient reason that it contained 30 per cent. of that salt. When the demand for gold extraction arose, it was at first entirely met by this process, the requisite ferrocyanide being obtained by the old fusion process from the nitrogen of horns, leather, &c. In 1891 the first successful process for the synthetic production of cyanide without the intervention of ferrocyanide was perfected, and the increasing demand from the gold mines was largely met by its use. At present the entire consumption of cyanide is not much short of 10,000 tons a year, of which the Transvaal goldfield consumes about one-third. Large cyanide works exist in Great Britain, Germany, France, and America, so that a steady and sure supply of the reagent has been amply provided. In 1894 the price of cyanide in the Transvaal was 2*s.* per pound; to-day it is one-third of that, or 8*d.* During the prevalence of the high prices of earlier years the manufacture was a highly speculative one, and new processes appeared and disappeared with surprising suddenness, the disappearance being generally marked by the simultaneous vanishing of large sums of money. To-day the manufacture is entirely carried out in large works scientifically organised and supervised, and, both industrially and commercially, the speculative element has been eliminated.

Chemistry has so often been called on to play the part of the humble and unrecognised handmaiden to the industrial arts that we may perhaps be pardoned if in this case we direct public attention to our Cinderella as she shines in her rightful position as the genius of industrial initiation and direction.

To this essentially chemical development of metallurgy we owe it that in a community the age of which can only be counted by decades we find ourselves surrounded by chemists of high scientific skill and attainments who have already organised for their mutual aid and scientific enlightenment "The Johannesburg Society of Chemistry, Metallurgy, and Mining," the published proceedings of which amply testify to the atmosphere of intellectual vigour in which the work of this great industry is carried on.

It appears, then, that while gold still maintains its position of influence in the affairs of men, the nature of that influence has undergone an important change. Not only has its widespread use as the chief medium of exchange exercised far-reaching effects on the commerce of the world, but the vastly increased demand for this purpose has in its turn altered the methods of production. These methods have become more highly organised and scientific, and gold production is now fairly established as a progressive industry in which scope is found for the best chemical and engineering skill and talent.

The experience of more highly evolved industries in the older countries has shown that the truly scientific organisation of industry includes in its scope a full and just consideration for the social and intellectual needs of its workers from highest to lowest. It augurs well, therefore, for the future of the gold industry, from the humane and social points of view, that its control should be more and more under the influence of men of scientific spirit and intellectual culture who we may feel assured will not forget the best traditions of their class.

The application of science to industry requires on the part of the pioneers and organisers keen and persistent concentration on certain well-defined aims. Any wavering in these aims or any relaxation of this concentration may lead to failure or to only a qualified success. This necessary but narrow concentration may be a danger to the intellectual development of the worker, who may thereby readily fall into a groove and so may become even less efficient in his own particular work. It certainly requires some mental strength to hold fast to the well-defined practical aim while allowing to the attention occasional intervals of liberty to browse over the wide and pleasant fields of science. But I am certain that the acquirement of this double power is well worth an effort. The mental stimulus, as well as the new experiences garnered during the excursion, will sooner or later react favourably on the practical problems, while the earnest wrestling with these problems may develop powers and intuitions which will lend their own charm to the wider problems of science.

Gold and Science.

If we re-peruse the table of the elements, not now in our capacity as "plain men" but as chemists, we shall certainly not select gold as of supreme interest chemically. Its position as chief among the noble metals, its patent of nobility, is based on its aloofness from common associations or attachments. Unlike the element nitrogen, it is mainly for itself and little if at all for its compounds, that gold is interesting. In it we can at our leisure study the *metal* rather than the *element*. Its colour and transparence, its softness and its hardness, the density as well as the extreme tenuity of some of its forms—such were the qualities which recommended it to Faraday when he desired to study the action of material particles on light. I should like to repeat to you in his own words the reasons he gave for this choice: "Because of its comparative opacity among bodies, and yet possession of a real transparency; because of its development of colour both in the reflected and transmitted rays; because of the state of tenuity and division which it permitted with the preservation of its integrity as a metallic body; because of its supposed simplicity of character; and because known phenomena appeared to indicate that a mere variation in the size of its particles gave rise to a variety of resultant colours. Besides the waves of light are so large compared to the dimensions of the particles of gold which in various conditions can be subjected to a ray, that it seemed probable that the particles might come into effective relations to the much smaller vibrations of the other particles."

I may remind you that Faraday came to the conclusion that the variety in the colours presented by gold under various conditions is due to the size of its particles and their state of aggregation. Ruby glass or ruby solutions he proved are not true solutions, nor are they molecular diffusions of gold, but they contain the metal in aggregates sufficiently large to give a sensible reflection under an incident beam of light. Through the kindness of Sir Henry Roscoe I am able to exhibit to you some of the original ruby gold preparations obtained during this research, which were afterwards presented to him by Faraday at the Royal Institution some years before his death.

By means of refined and ingenious optical methods Zsigmondy and Siedentopf have succeeded in making these ultra-microscopic particles visible in the microscope as diffraction discs; they have, further, counted the number of particles per unit area, and have from the intensity of their reflection calculated their size. In ruby glass the size of the particles in different specimens was found to vary from 4 to 791 millionths of a millimetre. No relation was found to hold between the colour of the particles and their absolute size. This conclusion is in direct contradiction of Faraday's belief already referred to. Mr. J. Maxwell Garnett has recently shown that the colour

of metallic glasses and films is determined, not only by the absolute size of the metal particles, but also by the proportion of the total volume they occupy in the medium in which they are diffused. The results of Mr. Garnett's calculations are in close agreement with a number of the observations on the colour and microstructure of thin metal films which I had already recorded, and they appear to me to supply the explanation of much that had appeared puzzling before. My own observations lead me to think that the actual microscopic particles which are to be seen, and the larger of which can also be measured, in films and solutions or suspensions, do not in any way represent the ultimate units of structure which are required by Mr. Garnett's theory, but that these particles are aggregates of smaller units built up in more or less open formation.

That a relatively opaque substance like gold may be so attenuated that when disseminated in open formation it becomes transparent is contrary to all our associations with the same operation when performed on transparent substances like glass or crystalline salts. The familiar experiment of crushing a transparent crystal into a perfectly opaque powder would not prepare us for the effect of minute subdivision on the transparence of metals. At first it might be supposed that this difference is due to the very rough and incomplete subdivision of the crystal by crushing; but this is not the case, for the perfectly transparent oxide of magnesium may be obtained in a state of attenuation comparable with that of the gold, by allowing the smoke from burning magnesium to deposit on a glass plate. The film of oxide obtained in this way is found to be built up of particles quite as minute as those of which the gold films are composed, yet the opacity of the oxide film is relatively much greater. The minute particles of the dielectric, magnesium oxide, scatter and dissipate the light waves by repeated reflection and refraction, while the similar particles of the metallic conductor, gold, act as electrical resonators which pass on some of the light waves while reflecting others. Specimens of films of gold and silver and of magnesium oxide are exhibited on the table and on the lantern screen. When the metallic particles are in this state of open formation and relative transparence, it was found that the electrical conductivity of the films had completely disappeared. Films of this description were found to have a resistance of more than 1,000,000 megohms as compared with only six ohms in the metallic reflecting condition.

Molecules in the Solid State.

My examination of gold films and surfaces has revealed the fact that during polishing the disturbed surface film behaves exactly like a liquid under the influence of surface tension. At temperatures far below the melting point molecular movement takes place under mechanical disturbance, and the molecules tend to heap up in minute mounds or flattened droplets. These minute mounds are often so shallow that they can only be detected when the surface is illuminated by an intense, obliquely incident beam of light. I have estimated that these minute mounds or spicules can be seen in this way in films which are not more than five to ten micro-millimetres in thickness. A film of this attenuation may contain so few as ten to twenty molecules in its thickness.

When moderately thin films of gold are supported on glass and heated at a temperature of 400°–500°, they become translucent, and the forms assumed under the influence of surface tension can be readily seen by transmitted light. It was in this way that the beautiful but puzzling spicular appearance by obliquely reflected light was first explained as due to the granulation of the surface under the influence of surface tension. Photomicrographs of these films are exhibited.

Turning now to the mechanical properties of metals, we find that gold has proved itself of great value in the investigation of some of these. It has long been recognised as the most malleable and ductile of the metals, whilst its chemical indifference tends to preserve it in a state of metallic purity throughout any prolonged series of operations.

The artificers in gold must very early have learned that its malleability and ductility are not qualities which indefinitely survive the operations of hammering and wire-drawing. A piece of soft gold beaten into a thin plate does not remain equally soft throughout the process, but spreads with increasing difficulty under the hammer. If carelessly beaten it may even develop cracks round its edges. We may assume that the artificers in gold very soon discovered that by heating, the hardened metal might be restored to its former condition of softness.

In connection with the study of the micro-metallurgy of iron and steel during recent years it has been recognised that heat annealing is, as a rule, associated with the growth and development of crystalline grains, and Prof. Ewing and Mr. Rosenhain have shown that overstrain is often if not invariably associated with the deformation of these crystalline grains by slips occurring along one or more cleavage planes. This hypothesis, though well supported up to a point by microscopic observations on a variety of metals, offers no explanation of the natural arrest of malleability or ductility which occurs when the overstrain has reached a point at which the crystalline grains are still, to all appearance, only slightly deformed. At this stage there is no obvious reason why the slipping of the crystalline lamellæ should not continue under the stresses which have initiated it. But far from this being the case, a relatively great increase of stress produces little or no further yielding until the breaking point is reached and rupture takes place.

The study of the surface effects of polishing, already referred to, had shown that the thin surface film retained no trace of crystalline structure; while it also gave the clearest indications that the metal had passed through a liquid condition before settling into the forms prescribed by surface tension. From this it was argued that the conditions which prevail at the outer surface might equally prevail at all inner surfaces where movement had occurred, so that every slip of one crystalline lamella over another would cause a thin film of the metal to pass through the liquid phase to a new and non-crystalline condition. By observations on the effects of beating pure gold foil, it was found that the metal reached its hardest and least plastic condition only when all outward traces of crystalline structure had disappeared. It was also ascertained that this complete destruction of the crystalline lamellæ and units could only be accomplished in the layers near the surface, for the hardened substance produced by the flowing under the hammer appears to encase and protect the crystalline units after they become broken down to a certain size. By carefully etching the surface in stages by means of chlorine water or cold aqua regia, the successive layers below the surface were disclosed. The surface itself was vitreous; beneath this was a layer of minute granules, and lower still the distorted and broken-up remains of crystalline lamellæ and grains were embedded in a vitreous and granular matrix. The vitreous-looking surface layer represents the final stage in the passage from soft to hard, from crystalline to amorphous. By heating the beaten foil, its softness was restored; and on etching the annealed metal it was found that the crystalline structure also was fully restored. Photomicrographs showing these appearances are exhibited. These microscopic observations were fully confirmed by finding well-marked thermo-electrical and electro-chemical distinctions between the two forms of metal, the hard and soft or the amorphous and the crystalline. The determination of a definite transition temperature at which the amorphous metal passes into the crystalline metal further confirms the phase view of hardening by overstrain and softening by annealing.

It was subsequently proved that *the property of passing from crystalline to amorphous by mechanical flow, and from amorphous to crystalline by heat at a definite transition temperature, is a general one which is possessed by all crystalline solids which do not decompose at or below their transition temperature.* The significance of this fact I venture to think entitles it to more than a passing reference. It appears to me to mean that the transition from amorphous to crystalline is entitled to take its place with the other great changes of state, solid to liquid, liquid to gas, for like these it marks a change in the molecular activity which occurs when a certain temperature is reached. It is entitled to take this place because there is every indication that the change is as general in its nature as the other changes of state. Compare it, for instance, with the allotropic changes with which chemists have been

familiar. These are for the most part changes which are special to particular elements or compounds, and are usually classed with the chemical properties by which the substances may be distinguished from each other. Very different is the amorphous crystalline change, for although in particular cases it may have been observed and associated with allotropic changes, yet the causes of its occurrence are more deeply founded in the relations between the molecules and the heat energy by which their manifold properties are successively unfolded as temperature is raised from the absolute zero. At this transition point we find ourselves face to face with the first stirrings of a specific directive force by which the blind cohesion of the molecules is ordered and directed to the building up of the most perfect geometric forms. It is hardly possible any longer to regard the stability of a crystal as static and inert, and independent of temperature; rather must its structure and symmetry be taken as the outward manifestation of a dynamic equilibrium between the primitive cohesion and the kinetic energy imparted by heat. Even before the discovery of a definite temperature of transition from the amorphous to the crystalline phase we had in our hands the proofs that in certain cases the crystalline state can be a state of dynamic, rather than of static equilibrium. The transition of sulphur from the rhombic to the prismatic form supplies an example of crystalline stability which persists only between certain narrow limits of temperature. Within these limits the crystal is a "living crystal" if one may borrow an analogy from the organic world. It can still grow, and it will under proper conditions repair any damage it may receive.

The passage of the same substance through several crystalline phases, each only stable over a limited range of temperature, strongly supports the general conclusion drawn from the existence of a stability temperature between the amorphous and crystalline phases, namely, that the crystalline arrangement of the molecules requires for its active existence the particular kind or rate of vibration corresponding with a certain range of temperature. Below this point the crystal may become to all appearance a mere pseudomorph with no powers of active growth or repair. But these powers are not extinct—they are only in abeyance ready to be called forth under the energising influence of heat. This temporary abeyance of the more active properties of matter is strikingly illustrated by the early observations of Sir James Dewar at the boiling point of liquid air, and more recently at that of liquid hydrogen. At the latter temperature even chemical affinity becomes latent. In metals it was found that the changes in their physical properties brought about by these low temperatures are not permanent, but only persist so long as the low temperature is maintained. During the past year Mr. R. A. Hadfield has supplemented these earlier results by making a very complete series of observations on the effect of cooling on the mechanical properties of iron and its alloys. The tenacity and hardness of the pure metal and its alloys at the ordinary temperature and at -182° have been compared, and it has been found that these qualities are invariably enhanced at the lower temperature, but that they return exactly to their former value at the ordinary temperature. By the mere abstraction of heat between the temperatures of 18° and -182° the tensile strength of pure metals is raised 50 to 100 per cent. In pure iron the increase is from 23 tons per square inch at 18° C. to 52 tons at -182°; in gold from 15·1 tons to 22·4 tons; and in copper from 19·5 tons to 26·4. This increase is not, I think, due to the closer approximation of the molecules, for the coefficient of expansion of most metals below 0° is extremely small. Neither is it due to permanent changes of molecular arrangement or aggregation, for Mr. Hadfield has obtained a perfectly smooth and regular cooling curve for iron between 18° and -182°, and there appears to be no indication of the existence of any critical point between these temperatures. Further, the complete restoration of the original tenacity on the return to the higher temperature shows that no permanent or irreversible change has occurred during cooling. Everything therefore indicates that the increase of tenacity which occurs degree by degree as heat is removed is due to the reduction of the repulsive force of molecular vibration, so that the primary cohesive force can assert itself more and more completely as the absolute zero is approached.

The metals experimented with by Mr. Hadfield were all in the annealed or crystalline condition, so that the molecules must have exerted their mutual attractions along the directed axes proper to this state. It is to be expected that similar experiments with the metals in the amorphous state may throw light on the question whether and to what extent the crystalline state depends on a dynamic equilibrium between the forces of cohesion and repulsion, or whether a directed cohesion exists fully developed in the molecules at the absolute zero.[1]

The phenomena of the solid state throw an interesting light on the interplay of the two great forces, the primative or blind cohesion which holds undisputed sway at the absolute zero, and the repulsion due to the molecular vibrations which is developed by heat. This interplay we know continues through the states which succeed each other as the temperature is raised, until a point is reached at which the molecular repulsions so far outweigh the cohesive force that the substance behaves like a perfect gas. The problems of molecular constitution are more likely to be elucidated by a study of the successive states between the absolute zero and the vaporising temperature than at the upper ranges where the gaseous state alone prevails. The simplicity of the laws which govern the physical behaviour of a perfect gas is very attractive, but we must not forget that this simplicity is only possible because repulsion has so nearly overcome cohesion that the latter may be practically ignored. The attractiveness of this simplicity should not blind us to the fact that it is in the middle region, where the opposing forces are more nearly equal, that the most interesting and illuminating phenomena are likely to abound. The application of the gas laws to the phenomena of solution and osmosis appears to be one of those cases in which an attractive appearance of simplicity in the apparent relations may prove very misleading.

Before passing from the specially metallic qualities of gold I will only remind you of the important part it has played in the researches on the diffusion of metals by the late Sir William Roberts-Austen, and in those of Mr. Haycock and Mr. Neville on the freezing points of solutions of gold in tin, which led to the recognition of the monatomic nature of the molecules of metals.

Molecules in Solution.

It has occurred to me that the practice of the cyanide process of gold extraction presents us with several new and interesting aspects of the problems of solution. As you are aware, the gold is first obtained from the ore in the form of a very dilute solution of cyanide of gold and potassium from which the metal has to be separated, either by passing it through boxes filled with zinc shavings, or by electrolysis in large cells.

The solution as it leaves the cyanide-vats may contain gold equal to 100 grains or more per ton, and as it leaves the precipitating-boxes it may contain as little as 1 or 2 grains and as much as 20 grains. In the treatment of slimes much larger volumes of solution have to be dealt with, and in this case solutions containing 18 grains per ton have been regularly passed through the precipitating-boxes, their gold content being reduced to $1\frac{1}{2}$ grains per ton. In round numbers we may say that 1 gram of gold is recovered from 1 cubic metre of solution, while 0·1 gram is left in the solution. Even from the point of view of the physical chemist we are here in presence of solutions of a very remarkable order of dilution. A solution containing 1 gram per cubic metre is in round numbers N/200,000, and the weaker solution containing 0·1 gram is N/2,000,000. It is convenient to remember that the latter contains a little more than $1\frac{1}{2}$ grains per ton. In experiments on the properties of dilute solutions the extreme point of dilution was reached by Kohlrausch, who employed solutions containing 1/100,000 of a gram-molecule of solute per litre for his conductivity experiments. These solutions were therefore twice as strong as the gold solution with 1 gram per cubic metre, and twenty times as strong as the

[1] Since the above was written a series of observations has been made on the influence of low temperature on the tenacity of pure metals in the amorphous condition. These observations will form the subject of a separate communication to the Section.

more dilute solution. This fact must be my excuse for placing before you the results of a few simple calculations as to the molecular distribution in these solutions, which have certainly given me an entirely new view of what constitutes a really dilute solution from the molecular point of view.

In estimating the number of molecules in a given volume of solution the method adopted is to divide the space into minute cubical cells, each of which can exactly contain a sphere of the diameter of the molecule. In this way a form of piling for the molecules is assumed which, though not the closest possible, may quite probably represent the piling of water molecules. Taking the molecular diameter as $0{\cdot}2\times10^{-6}$ millimetres—a figure which is possibly too small for the water molecules and too large for the gold —it is found that a cubic millimetre of solution contains 125×10^{15} molecules, or 125 quadrillions. The head of an ordinary pin, if it were spherical, would have a volume of about 1 cubic millimetre.

If these water molecules could be arranged in a single row, each molecule just touching its two nearest neighbours, the length of the row would be 25,000,000 kilometres. A thread of these fairy beads, which contained the molecules of one very small drop of a volume of 6 cubic millimetres, would reach from the earth to the sun, a distance of about 150,000,000 kilometres.

In a solution containing $1\frac{1}{2}$ grains of gold per ton, or 1 decigram per cubic metre, the ratio of gold molecules to water molecules is as 1 : 193,000,000. Each cubic millimetre of the solution, therefore, contains 6,500,000,000 gold molecules. If these are uniformly distributed throughout the solution each will be about 400 micro-millimetres, or 1/60,000 of an inch, from its nearest neighbours. This is not really very wide spacing, for the point of the finest sewing-needle would cover about 1,500 gold molecules.

If a cubic metre of solution could be spread out in a sheet one molecule in thickness it would cover an area of 1,680 square miles, and nowhere in this area would it be possible to put down the point of the needle without touching some hundreds of gold molecules simultaneously.

According to Prof. Liversidge, sea-water contains on the average about 1 grain of gold per ton. If this is the case, then the above figures for the dilute cyanide solution apply with only a slight modification to sea-water. No drop, however small it may be, can be removed from the ocean which will not contain many millions of gold molecules, and no point of its surface can be touched which is not thickly strewn with these. From this molecular point of view we must realise that our ships literally float on a gilded ocean!

From time to time adventurers arise who attempt to launch upon this gilded ocean unseaworthy ships freighted with the savings of the trusting investor. In order that nothing which has been said here may tempt anyone to contribute to the freighting of these ships, let me hasten to point out that the weakest of the cyanide solutions here referred to is richer in gold than sea-water is reported to be. The practical conclusion from this comparison is sufficiently obvious. If the cyaniding expert, whose business it is to extract gold from dilute solutions, finds that it does not pay to carry this extraction beyond a concentration of 2 or 3 grains per ton, even when the solution is already in his hand, and when, therefore, the costs of treatment are at their minimum, how can it possibly pay to begin the work of extraction on sea-water, a solution of one-half the richness, which would have to be impounded and treated by methods which could not fail to be more costly in labour and materials than the simple process of zinc-box precipitation? It is generally unsafe to prophesy, but in this case I am rash enough to risk the prediction that if ever the gold mines of the Transvaal are shut up it will *not* be owing to the competition of the gold resources of the ocean.

In these calculations with reference to the dilute cyanide solutions it is assumed that the gold molecules are uniformly distributed, that they are practically equidistant from each other. There appears to me to be considerable doubt whether we have any right to make this assumption. Leaving out of account for the moment the action of the water molecules, it would appear that as long as the gold molecules are so numerous that a uniform distribution would bring them within the range of each other's attraction, we can imagine that all submerged molecules would be in equilibrium so far as the attractions of their own kind are concerned, being subjected to a uniform pull in all directions. This condition would certainly make for uniform distribution. But when the distance between them exceeds the range of the molecular forces, it is evident that an entirely new condition is introduced, and it seems not improbable that the widely distributed molecules would tend to drift into clouds in which they are brought back within the range of these forces. The range of the cohesive forces in water and aqueous liquids is usually taken from 50 to 100 micro-millimetres, and I am disposed to think that ten times this amount would not be an excessive estimate of the range in the case of gold. If the range for gold be taken as 500 micro-millimetres, then the gold molecules of the dilute gold solution, which are spaced at 400 micro-millimetres apart, are just within the range of each other's attraction, and their distribution is, therefore, likely to be uniform. But by a further dilution to half concentration, the equilibrium would be liable to be disturbed, and denser clouds of gold molecules would be formed, with less dense intervals between them.

In preparing the zinc boxes through which the gold solution is passed, very great care has to be exercised to ensure that the contact surface of the zinc is used to the best advantage. With this object the packing of the zinc shavings is so managed that the solution is spread over the zinc surface in as thin sheets as possible. The object, of course, is to bring as many of the gold molecules as possible into actual contact with the zinc. The gold molecules found in the solution leaving the boxes are those which have not been in contact with the zinc. Yet we have seen that these molecules are still so numerous that they are within 1/60,000 of an inch of each other. If these molecules are in a state analogous to the gaseous state, with diffusive energy of the same order as that of the gas molecule, it is difficult to imagine how they can escape without coming in contact with the zinc surface during their tortuous passage through the boxes and being deposited there. Yet they do escape, even when the velocity of the solution in passing over the zinc surfaces is so slow as 10 cm. per minute or 1·6 mm. per second.

We may regard the condition of these isolated gold molecules, or the more complex auricyanide of potassium molecules, as typical of that of the solute molecules in a dilute solution of any non-volatile solid. They are *solid* molecules sparsely distributed among a multitude of intensely active solvent molecules, the temperature of the solution being many hundred degrees below that at which they could of themselves assume the greater freedom of the liquid or gaseous state. These solute molecules have to a great extent been set free from the constraining effect of their cohesive forces, *but it is important to remember that this freedom has not been attained by the increase of their own kinetic energy as in liquefaction by heat.* Their freedom and the extra kinetic energy they have acquired have in some way been imparted to them by the more active solvent molecules; for, if the solvent could be suddenly removed, leaving the solute molecules still similarly distributed in a vacuous space, they would eventually condense into a solid aggregate. This must be the case, for the non-volatile solute has no measurable vapour pressure at the temperature of the solution. The kinetic energy of the solute molecules is of itself quite insufficient to endow them with the properties of the gaseous or even of the liquid molecule, even when their cohesive forces have been weakened or overcome by separation.

If the energy employed in this separation is not intrinsic to the solute molecule then it must in some way have been imparted by the solvent molecules. It therefore becomes important to compare the energy endowment of one set of molecules with that of the other.

Compared with other solids, ice at its freezing point has very little hardness or tenacity: the cohesion of its molecules has been much relaxed by the great absorption of heat energy between the absolute zero and the freezing point. If an average specific heat of 0·5 over the whole range be assumed, the heat absorption of one gram amounts to 136·5 calories. In the transition to the liquid state at 0° a further absorption of 79 calories takes place, so that

a gram of liquid water at the freezing point contains the heat energy of 215·5 calories. The fact that water has the high vapour pressure of 4·6 mm. of mercury at the freezing point is probably a result of this enormous store of energy. As a liquid, therefore, it is natural to expect that its molecules will exhibit effects proportionate to this great store of energy. This expectation appears to be realised when we consider not only its properties as the universal solvent, but its osmotic and diffusive energy in solutions in which it is the solvent.

To complete the comparison it is only necessary to calculate the heat energy of gold at 0°. Taking its specific heat as 0·032, a gram of gold at 0° contains 8·7 calories. A gram-molecule, therefore, contains in round numbers 1700 calories as compared with 3880 calories in a gram-molecule of water.

Taking into consideration not only this greater store of energy, but also the much smaller cohesive force of water as compared with the majority of solid solutes, there can be no doubt that the active *rôle* in aqueous solutions of this type must be assigned to the solvent, not to the solute molecules.

This leads to the important conclusion that the energy of solution, of diffusion, and of osmosis is due, not to the imaginary gaseous energy of the solute, but to the actual liquid energy of the solvent molecules. When this conclusion is reached a new physical explanation of these phenomena is in our hands, and we are relieved from the strain to the imagination involved in the application of the gas theory to solutions of non-volatile solids.

This transference of the active *rôle* to the solvent molecules does not in any way affect the well-established conclusions based on the laws of thermodynamics as to the energy relations in these phenomena, for it has always been recognised that these conclusions have reference to the average conditions prevailing in large collections of relatively minute units. Wherever the gas analogy has appeared to hold it has not necessarily involved more than this, that the observed effects are in proportion to the number of these minute units in a given volume.

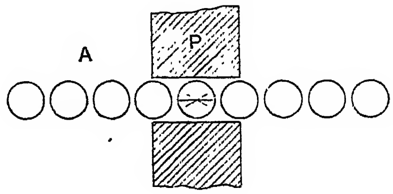
In applying the gas theory to the physical explanation of osmotic pressure it has been the custom to regard this pressure as directly due to the bombardment of the semi-permeable membrance by the solute molecules. But this conception completely ignores the fact that the pressure developed is a hydrostatic, not a gaseous pressure, and that the hydrostatic pressure results directly from *the penetration of the solvent molecules from the other side of the partition.*

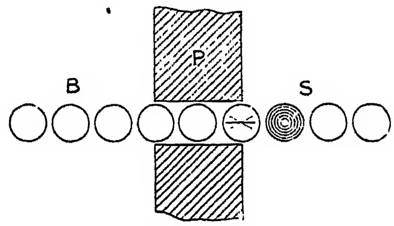
It appears to me more natural to abandon the gas analogy altogether, to regard the molecules as in the solid and liquid condition proper to their temperature, and to apportion to them their respective parts in the active changes according to their obvious endowment of energy.

Applying this view to the case of a solution and a solvent separated by a semi-permeable membrane, it is seen that the pressure rises on the solution side, because the pure solvent molecules on the other side have some advantage for the display of their energy over the similar molecules in the solution. *This effect in its most general form may be attributed to the dilution of the solvent by the solute molecules.* In cases where the osmotic pressure appears to obey Boyle's law the effect is exactly measured by the number of solute molecules per unit volume. But the facts of this position are in no way changed if the effect is taken to be due to the activity of an equal number of solvent molecules, for we then see that each solute molecule by cancelling the activity of one solvent molecule on the solution side permits a solvent molecule from the other side to enter the solution.

What the exact mechanism of this cancellation is there is at present no evidence to show, and the caution originally given by Lord Kelvin with reference to the undue forcing of the gas analogy must also be applied to the suggestion now put forward. But as a means of making the suggestion a little more clear I give here a simple diagram on which A represents a single perforation in a semi-permeable membrane, P, on both sides of which there is only pure solvent. For the sake of clearness the molecules are shown only as a single row. Normally there will be no passage of solvent molecules from side to side, for the average kinetic energy of the molecules on both sides is equal. This state of equilibrium is indicated on the diagram by marking with a cross the molecule which is exactly halfway through the partition.

At B a single solute molecule, S, has been introduced at the right side. If this molecule exactly cancels the energy of one solute molecule at its own end of the row, the equilibrium point will move one molecule to the right, the solvent molecules will move in the same direction, and one of their number will enter on the solution side. So long as the row includes one, and only one, solute molecule, the equilibrium will remain unchanged and no more solute molecules will pass in. If another solute molecule arrives





on the scene, the equilibrium will again be disturbed in the same way as before, and another solvent molecule will pass into the solution.

This mechanism accomplishes to some extent the work of a "Maxwell Demon," in so far at least as it takes advantage of the movement of *individual molecules* to raise one part of a system at a uniform temperature to a higher level of energy.

A Mechanical View of Dissociation in Dilute Solutions.

The view that the phenomena of solution depend on the relative kinetic energy of the solvent and solute molecules appears to apply with special force to the phenomena of dissociation in dilute solutions. Under the gas theory there does not appear to be any reason why the solute molecules should dissociate into their ions. So obvious is this absence of any physical motive that Prof. Armstrong has happily referred to the dissociation as "the suicide of the molecules." Others have proposed to ascribe the phenomenon to what might be called "the fickleness of the ions," thus supposing that the ions have an inherent love of changing partners. These may be picturesque ways of labelling certain views of the situation, but the views themselves do not appear to supply any clue to the physical nature of the phenomena. With the acceptance of the view that the phenomena of solution are largely due to the kinetic energy of the solvent molecules, the phenomena of dissociation also appear to take their place as a natural result of this activity. For consider the situation of an isolated molecule of cyanide of gold and potassium closely surrounded by and at the mercy of some millions of water molecules all in a state of intense activity. The rude mechanical jostling to which the complex molecule is subjected will naturally tend to break it up into simpler portions which are mechanically more stable. The mechanical analogy of a ball mill in which the balls are self-driven at an enormous velocity is probably rather crude, but it may at least help us to picture what, on the view now advanced, must be essentially a mechanical operation.

In importing this mechanical view of the breaking down of complex into simpler molecules we are not without some solid basis of facts to go upon. My own observations have shown that even in the solid state the crystalline molecule can be broken down by purely mechanical means

into the simpler units of the amorphous state; and, further, that the water molecules of a crystal may by the same agency be broken away from their combination with the salt molecules. Since the publication of the earlier of these observations Prof. Spring has shown that the acid sulphates of the alkali metals may be mechanically decomposed into two portions, one of which contains more acid, and the other more base than the original salt. It is important to recognise that in these three apparently short steps the transition has been made from the overcoming of the simple cohesion of similar molecules in contact with each other to the breaking asunder of the chemical union of dissimilar molecules. At each step the solid molecules appear, not as mere ethereal abstractions, but as substantial portions of matter which can be touched and handled mechanically.

The physical properties of a gas are primarily due to its being an assemblage of rapidly moving molecules. These simpler and more general properties can coexist with, and may be modified by, the more complex relations introduced by chemical affinity as it occurs in compound gases and mixtures.

It appears to me quite legitimate similarly to regard the physical properties of a *liquid* as due to its being an assemblage of rapidly moving molecules. The liquid system is highly condensed, and the motions of its molecules are controlled by the cohesive as well as by the repulsive forces. The closer approximation of the molecules may reduce their mean free path to an extremely small amount, or it may even cause their translatory motion to disappear, so that the whole kinetic energy of the liquid molecules may be in the form of rotation or vibration.

As we can imagine a perfect gas, so also may we imagine a perfect liquid, the physical properties of which are as simply related to the laws of dynamics as are those of the gas. But the conditions of the liquid state being also those most favourable to the play of chemical affinity, the internal equilibrium of solutions or of mixed liquids must be a resultant of this affinity together with the primary forces of the ideal liquid state.

An ideally perfect solution—that is, a solution the physical properties of which are determined solely by the number of molecules it contains in a given volume—must consist of a solvent and a solute which have no chemical affinity for each other, so that their molecules will neither associate nor dissociate in solution. Probably only comparatively few solutions will be found which even approximate to this ideal perfection. But it appears to me that the study of the problems of the liquid and the dissolved states may be much simplified by the recognition (1) that the primary physical properties of liquids and solutions are due to the fact that they are assemblages of molecules endowed with the amount and the kind of kinetic energy which is proper to their temperature; and (2) that as these primary physical properties of the liquid and dissolved states may be masked and interfered with by chemical affinity, they should be studied as far as possible in examples where the influence of this force is either absent or at a minimum.

NOTES.

WE regret to learn of the death, at the age of seventy-eight, of Dr. T. R. Thalén, professor of physics at the University of Upsala, and one of the most eminent Swedish men of science. The Rumford medal was awarded to him by the Royal Society for his researches on spectrum analysis, and a gold medal was awarded to him by the Swedish Association of Ironmasters in 1874 for his investigations of magnetic iron ore deposits.

A REUTER telegram from Berlin states that the International Conference for the Investigation of Earthquakes met on Tuesday at the Ministry of the Interior, under the presidency of Privy Councillor Dr. Lewald. All the States which possess organised staffs for the investigation of earthquakes were invited by the German Government to take part in the conference. The conference is expected to last two days.

THE Government Eclipse Expedition in charge of Sir Norman Lockyer, K.C.B., has arrived at Palma, Balearic Islands, where the instruments will be erected for observations of the total solar eclipse on August 30. A Reuter telegram from Madrid reports that the telegraph authorities have decided to frank all telegrams dispatched by members of the various astronomical expeditions regarding observations of the eclipse.

THE London County Council has erected a memorial tablet on No. 14 Hertford Street, Park Lane, where Edward Jenner, the originator of vaccination, resided in 1803; and also on No. 34 Gloucester Square, Hyde Park, where Robert Stephenson, the engineer, resided at one time.

THE death is announced of the Rev. Dr. J. Keith. He was one of the leading educationists of the north of Scotland, and took an active interest in scientific pursuits, especially botany.

THE *Times* correspondent at Wellington, N.Z., states that the Postmaster-General hopes, with the cooperation of Australia, to have wireless telegraphy established across the Tasman Sea within twelve months. The cost will be 28,000*l*.

THE meeting of the tenth International Navigation Congress will be held at Milan from September 24–30. Particulars can be obtained from the secretary, M. Dufourny, 38 Rue de Louvain, Brussels, or from M. Saujast Di Teulada, Villa Real, Milan.

MR. W. E. LANGDON, formerly telegraph superintendent and chief of the electrical department of the Midland Railway, died on Saturday last, August 12. He was for many years a member of the Institution of Electrical Engineers, and was president for the session of 1901–2.

PROFS. RUBERT BOYCE AND RONALD ROSS, of the Liverpool School of Tropical Medicine, left Liverpool on Saturday by the *Campania* for New York. They are proceeding to New Orleans, their services having been offered to the authorities in connection with the outbreak of yellow fever at that port.

A REUTER message from Hong Kong, dated August 12, reports that for nine hours a continuous series of earthquake shocks, two of them prolonged, have been felt at Macao. Slight shocks have been experienced in Hong Kong. An earthquake shock was felt at Chamonix on August 13, at 10.30 a.m. The usual subterranean rumbling noise was heard.

MR. GERALD DUDGEON has been appointed by the Secretary of State for the Colonies to examine and report upon questions relating to the development of the agricultural resources (including cotton) of British West Africa. His title is Superintendent of Agriculture for the British West African Colonies and Protectorates.

THE weather report issued by the Meteorological Office for the week ending August 12 shows that in all the eleven districts into which the British Islands are divided the rainfall since the beginning of the year is below the average, except in the north of Scotland, where the excess is 5·2 inches. The deficiency amounts to 4·6 inches in the north-east of England, and to 3·0 inches in the Midland counties. While at the end of the week in question nearly the whole of England and Ireland were under the influence

of high barometric pressure, an area of low pressure lay over Italy and the Adriatic; these conditions caused an unusually heavy fall of rain over the whole of Switzerland during the night of August 11–12, exceeding 2 inches in amount at several places, with early snowfall at the high-level stations.

IN a recent issue (August 5) the *Academy* directs attention to a curious poetical tribute—composed by a French mathematician—to Archimedes, referring to the evaluation of π, which, set out in thirty places of decimals, is 3·141592653589793238462643383279. It will be observed that each of the thirty-one words in this quatrain contains the number of letters corresponding with the successive numbers in the numerical expression:—

3 1 4 1 5 9 2 6 5 3 5
Que j'aime à faire apprendre un nombre utile aux sages
8 9 7 9
Immortel Archimède, artiste ingénieur!
3 2 3 8 4 6 2 6
Qui de ton jugement peut priser la valeur?
4 3 3 8 3 2 7 9
Pour moi ton problème eut de pareils avantages.

The *Frankfurter Zeitung* reproduces the French verse, and adds a similar effort emanating from a German poet and geometrician:—

3 1 4 1 5 9 2 6 5
Dir, o Held, o alter Philosoph, Du Riesen-Genie!
3 5 8 9 7
Wie viele Tausende bewundern Geister,
9 3 2 3 8
himmlisch wie Du und göttlich!—
4 6 2 6
Noch reiner in Aeonen
4 3 3 8
wird das uns strahlen,
3 2 7 9
wie im lichten Morgenrot!

The *Academy* asks for English parallels to these efforts.

THE fifth instalment of the "Fauna of New England" has just been issued in the seventh volume of *Occasional Papers of the Boston (U.S.A.) Society of Natural History*, and comprises a list of the crustacea, by Miss M. J. Rathbun. The number of species recorded is 390.

WE have received a copy of the sixth annual report of the Plymouth Municipal Museum and Art Gallery, in which are recorded the additions made to the collections during the past year, which are numerous. As regards the biological and geological sections, the committee is apparently of opinion that a miscellaneous *omnium gatherum* is preferable to a representative local collection—an opinion not shared by ourselves. In looking over the list of additions to the geological series, we were somewhat surprised to find the entry of a cast as *Archaeopteryx sinensis*, which is, however, evidently a misprint for *A. siemensi*. We also notice molybdinite in place of molybdenite.

THE latest issue (vol. xv., part ii.) of the *Proceedings of the Cotteswold Naturalists' Field Club* contains two papers dealing with local subjects, namely, one by Mr. L. Richardson on the effects of earth-pressure on the Keuper rocks in the neighbourhood of Eldersfield, and a second, by Mr. C. Upton, on some Cotteswold Oolitic brachiopods. In the latter communication the author, after alluding to the extreme difficulty of determining the various forms of Rhynchonella, feels himself justified in describing two species of that genus as new, and likewise two new terebratulas. Other papers deal with rock specimens from Cyprus, experiences in Korea, and certain early Indian stone monuments.

THE third part of vol. xxv. of *Notes from the Leyden Museum*, issued on April 15, comprises eleven short articles dealing with various invertebrate groups, among which one on Trochidæ by Mr. M. M. Schepman, and a second on the collection of chitons in the Leyden Museum by Dr. H. F. Nierstrasz, are illustrated. Among the other contents reference may be made to five by Mr. C. Ritsema on various groups of beetles, and a sixth by Mr. E. Jacobson (communicated by the Rev. E. Wasmann) on the Javan ant *Polyrhachis dives*. It is well known that the oriental ant *Œcophylla smaragdina* has the remarkable habit of employing its larvæ (which have special silk-glands for making their own cocoons) to glue together the edges of leaves for the benefit of the ants themselves, and the Javan species uses its larvæ in the same manner to spin nests.

IN the *Records of the Australian Museum* (vol. vi., part i.) Mr. R. Etheridge describes the fore-part of a huge fish from the Lower Cretaceous of Queensland allied to the well known Portheus and Ichthyodectes of the same epoch. The specimen is provisionally assigned to the former genus, with the designation *I. marathonensis*, in reference to Marathon, its place of origin on the Flinders River. Later on in the same journal Mr. W. J. Rainbow makes an interesting addition to the subject of social spiders. It appears that some time ago the museum received two huge shawl-like webs taken from the Jenolan Caves, the larger of which measures 12 feet in length and about 4 feet in maximum width. Both webs are closely wrought, and are evidently the work of a large community of a spider referred to new species under the name of *Amaurobius socialis*.

To the May issue of the *Proceedings of the Philadelphia Academy* Mr. B. Smith contributes a suggestive paper on senility in gastropods, mainly based on the study of the Tertiary genus Volutilithes. In most extinct gastropods changes of ornamentation may be observed as the earlier are compared to the later whorls; a normal succession of such changes being noticeable, which varies but little in widely sundered groups, although most families display certain distinctive features in this respect. Infancy, youth, and maturity are represented by distinctive styles in the ontogeny of a species, but these stages cannot always, perhaps from the imperfection of the geological record, be correlated with ancestral types. Senile features, of which several usually occur together in the last whorl, do not all necessarily appear at exactly the same time in the ontogeny. Senile species or genera never transmit descendants, being the terminal members of short branches. Evolution among gastropods seems, indeed, to work sometimes rapidly and sometimes slowly, those forms in which it is rapid and bizarre constituting the aforesaid senile offshoots.

REJUVENATION (Verjungung) forms the subject of an interesting communication by Mr. E. Schultz, of St. Petersburg, to *Biologisches Centralblatt* of July 15. Starting with the fact that in the genital chamber of fasting planarians not only may the whole organ be seen to undergo a retrograde development to its original embryological condition, but the differentiated epithelial cells of this organ may be observed to lose their mutual connection, to become rounded, and to resume their embryological state; the author proceeds to argue that periods

of fasting and torpor, together with the phenomenon of encysting, are of great importance in regard to the rejuvenation of tissue, and consequently to the duration of life of the animal. *Primâ facie,* such periods of rest and rejuvenation would seem to imply longevity in the species in which they occur, and it is therefore suggested that such animals as dormice, badgers, bats, moles, bears, hamsters, and tortoises and many other reptiles are in all probability long-lived. Except in the case of tortoises, our information on this point is, however, very defective. On the other hand, some other explanation must be sought for the longevity which is known to occur in many kinds of birds. The paper concludes with speculations and theories connected with the subject.

IN the July number of the *Psychological Bulletin* (ii., No. 7) Mr. Shepherd Franz describes anomalous time reactions in a case of manic-depressive depression.

THE Bulletin of the Johns Hopkins Hospital for July (xvi., No. 172) contains an interesting contribution to the history of medicine in Maryland during the revolution (1775–1779) by Dr. Walter Steiner, various medical articles, proceedings of societies, &c.

THE *Journal of Anatomy and Physiology* for July (xix., part iv.) contains papers by Dr. Gaskell, F.R.S., on the origin of the vertebrates deduced from the study of the ammocœtes, by Dr. Wright on skulls from the round barrows of east Yorkshire, by Dr. Cameron on the development of the retina in Amphibia, and a report by Dr. Bertram Windle on recent teratological literature, together with several articles of anatomical interest.

THE *Journal of Hygiene* for July (v., No. 3) contains papers on canine piroplasmosis by Drs. Nuttall, Graham Smith, and Wright, and one on bovine piroplasmosis by Mr. Mettam. Dr. Boycott details an experimental case of skin infection with ankylostoma, and Mr. MacConkey contributes an important paper on lactose-fermenting bacteria in fæces. Colonel Leishman, Captain Harrison, and Lieuts. Smallman and Tulloch describe very fully an investigation upon the blood changes following anti-typhoid inoculation; this and several other interesting papers complete the contents of an excellent number.

IN a report on the metropolitan water supply, Dr. Scott Tebb, the public analyst for Southwark, points out that five out of the seven committees of inquiry which have investigated the quality of the Thames water have condemned the river as a source of domestic supply to the metropolis, that the quality of the water as indicated by analysis has shown no substantial improvement during the last thirty years, that the river is extensively polluted, and that it is doubtful if this can ever be prevented. He therefore recommends that London should as soon as possible abandon the Thames as a source of domestic supply, a conclusion neither new nor novel. But when in the body of the report it is stated that "we know nothing of the essential cause of either typhoid fever or cholera, and the medical profession is as much in the dark now as it was 40 years ago" (respecting these diseases), it becomes doubtful how much weight should be attached to Dr. Tebb's conclusions. A large portion of the report is filled with abstracts from papers and books, mostly old, attempting to show that the cholera vibrio and typhoid bacillus have nothing to do with the respective diseases, the overwhelming evidence on the other side being completely suppressed.

A NUMBER of new plants or new localities for previously recorded Indian plants are given in Nos. 4 and 5 of vol. lxxiii., part ii., of the *Journal of the Society of Bengal*. Dr. Prain records several new species from Sikkim, including a Geum and a Potentilla, which are figured, five new species from Burma, and two new orchids from Chota Nagpur. Also Dr. Prain and Mr. Burkill have a note on a new yam, not, however, fit for food, which was collected abundantly in Burma. In another note Mr. J. R. Drummond describes a new Scirpus from Baluchistan, with some allied species.

IT is characteristic of the Americans that when they took over the Philippines they accepted also the responsibilities thereby entailed. In 1837 Father Blanco published a "Flora de Filipinas," enumerating more than a thousand species and varieties; the descriptions were in many cases imperfect, Blanco's knowledge of the plants of neighbouring countries was slight, and unfortunately his herbarium has been lost, so that except where types have been preserved in European herbaria, identification has been most difficult. Mr. E. D. Merrill has prepared a review of the three editions and appendix, of the flora to summarise present knowledge and to provide a basis for further identification by collectors; the volume forms No. 27 of the Publications of the Bureau of Government Laboratories, Manila.

IN the Botanic Gardens at Brussels special facilities have been provided for students for many years in the matter of plant collections, notably of economic, also of officinal and poisonous plants. More recently, in 1902, it was decided to lay out four groups of plants which should be geographical, systematic, evolutionary (phylogenique), and physiological (éthologique), in addition to a group of xerophytes. Copies of the pamphlets explaining the arrangements and the nature of the collections, which are supplied to students, have been received. The evolutionary collection is designed to illustrate variability, heredity, and the origin of new varieties and species. The plants that constitute the "collection éthologique" have been selected on account of their showing special developments, whether for nutrition, reproduction, or some other purpose. A house has been devoted to xerophytes ever since Demoulin's collection was presented in 1882; this has been extended, and a novel feature of the present system is the arrangement of a number of species of cactus as a practical exhibition of an evolutionary series.

MONEY-BOXES in the form of mammæ are made in Germany and Italy, and these form the subject of a paper by F. Rosen in *Globus* (lxxxvii. p. 277). In olden times the mamma was the symbol of abundance, blessings and wealth, therefore this form is peculiarly appropriate for money-boxes; but money-boxes are not ancient. In prehistoric times vessels were frequently made in the form of mammæ, and they are still so made by the folk. The author refers to the pomegranate as an ancient symbol of riches and good fortune; one half of it has some resemblance to a mamma, and the numerous seeds it contains suggest fertility. The mamma was certainly a luck-symbol, and Astarte, Aphrodite, and Isis were luck-goddesses. Astarte, Venus, and Isis were protective patronesses of sailors. He refers to the fact that one often finds money-boxes in the form of pigs; the "lucky pig" is an extremely common talisman in Germany. Pregnant sows were offered to Demeter or Ceres because of the great fertility of this animal. Leland ("Etruscan Roman Remains," p. 255) says, "Ceres was pre-eminently a

goddess of fertility, therefore of good luck and all genial influences; hence little gold and silver pigs were offered to her, and also worn by Roman ladies, partly to ensure pregnancy, and partly for luck."

The recent issues of the *Monthly Weather Review* of the U.S. Weather Bureau contain, *inter alia*, some important articles by Prof. Bigelow on the application of mathematics to meteorology, on the diurnal periods in the lower strata of the atmosphere, and on the observations with kites at the Blue Hill Observatory, from 1897–1902. In the first-named paper, the author points out that no branch of modern science has suffered more severely than meteorology by the misapplication of good mathematics to good observational data, and that the results of recent balloon and kite observations show that nearly the entire range of general theory of the circulation of the atmosphere must be pronounced a misfit. We think we are safe in saying that no other meteorological journal can compare with the *Monthly Weather Review* in its endeavour to popularise meteorological science, by the publication of original articles, reprints, and translations from foreign papers. The ordinary meteorological tables are based on data from about 3583 stations, some of which belong to countries outside the United States. Since December, 1904, the Weather Bureau has received a large number of reports giving simultaneous observations over the Atlantic and Pacific Oceans made at Greenwich—noon. These are charted, and, with corresponding land observations, will form the framework for daily weather charts of the globe. As a further instance of disseminating useful information, we may refer to an article on forecasting the weather and storms, by Prof. W. L. Moore, in the *National Geographic Magazine* for June, illustrated by a number of weather charts. The author points out, with justice, that to anyone who will read the text, and carefully follow the charts which illustrate and make it clear, the daily weather chart will be an object of interest as well as of pleasure and profit. Every step taken, from the receipt of the observations to the publication of the weather chart and preparation of forecasts, is explained with clearness and precision.

Several simple forms of instruments affording a rapid and accurate means of determining the paths of refracted and reflected rays through any optical system are described by Mr. J. R. Milne in the *Proceedings of the Royal Society of Edinburgh* (vol. xxv., p. 806):

It is well known that the minimum potential of a point discharge is increased by the discharge, a blunting or powdering of the point occurring. That the blunting is, however, not responsible for the rise in potential appears evident from a series of experiments made by Mr. F. R. Gorton and described in the *Verhandlungen* of the German Physical Society (vol. vii., p. 217), where it is shown that under the influence of either an ultra-violet radiation or the radiation of radium the blunted point recovers its original value for the minimum potential. The blunting of the point is thus a minor factor in the question, and the conditions are investigated in which constant, reproducible values can be obtained so that the subject may be more fully investigated.

In the July number of the *American Journal of Science* Mr. D. Albert Kreider describes a special form of voltameter in which the accuracy and sharpness of the volumetric method of estimating iodine by means of sodium thiosulphate are utilised. A special form of potassium iodide cell is adopted in which iodine is liberated by the action of the current; its amount is then readily ascertained by direct titration. The results obtained agree very closely among themselves if a certain current be not exceeded, the difference then not exceeding 1 part in 10,000; but the results are uniformly higher by 0·06 per cent. to 0·09 per cent. than are shown by a silver voltameter placed in the circuit. The rapidity and simplicity of the method should adapt it for practical application.

Prof. Balbiano, writing in the *Atti dei Lincei*, xiv., 12, gives an account (read June 18) of the work of Prof. Augusto Piccini, whose death occurred on April 16. While Piccini's most important researches were connected with the periodic law of Mendeléeff, attention is directed to a little-known article on oxygenated water written by him two years ago for the "Encyclopædia of Chemistry," in which the theory was advanced that the atoms of oxygen which it contains are in the form of a combination inferior to that of water.

An interesting application of the mathematical theory of elasticity is given by Prof. Vito Volterra in the *Atti dei Lincei*, xiv., 12. The problem is that of an elastic ring or hollow cylinder of rectangular radial section from which a slice is removed and the separated parts joined together, and the two cases are considered where the fissure is radial and where the portion removed is of uniform thickness. From calculation, the author found expressions representing increase of internal length, decrease of external length, and distortion of the lateral surface of the cylinder into a form concave outwards, and experiments conducted with actual cylinders of caoutchouc closely reproduced all the results of calculation.

Dr. Roberto Bonola, of Pavia, discusses in the Lombardy *Rendiconti*, xxxviii., 11, the theorems of Padre Gerolamo Saccheri on the sum of the angles of a triangle, in connection with Dehn's researches, Euclid's axiom of parallels, and the postulate of Archimedes. Saccheri's investigations were published at Milan in 1793 under the title "Euclides ab omni naevo vindicatus," and were based on the consideration of "bi-rectangular isosceles quadrilaterals," this term being used to designate a quadrilateral ABCD having $AB=CD$, and

$$\text{angle } ABC=BCD=90°.$$

In ordinary space such a quadrilateral is a rectangle. Padre Saccheri gives a proof that if one bi-rectangular isosceles triangle has its remaining angles acute, right, or obtuse, the same property will be true of every other such quadrilateral. From this he deduces that if one triangle has the sum of its angles greater to, equal to, or less than two right angles, the same will be true of every other triangle, *i.e.* the property commonly known as Legendre's theorem on the angles of a triangle. Dr. Bonola refers to Dehn's work in proving that Legendre's theorem is independent of the postulate of Archimedes, and he gives corresponding proofs in connection with Saccheri's work.

A sixth edition of Mr. A. B. Lee's "Microtomist's Vade-mecum: a Handbook of the Methods of Microscopic Anatomy," has been published by Messrs. J. and A. Churchill. The first edition of the work appeared in March, 1885, and was reviewed in our issue of June 18 of the same year (vol. xxxii. p. 147). Many of the suggestions made on that occasion have since been adopted. The text of the book has been even more condensed than in the last edition, and this plan has given room for much new matter. The chapter on staining with coal-tar colours

has been removed, this subject being now dealt with in the general chapter on staining, which has been re-written. The chapters on connective tissues, on blood and glands, and on the nervous system have been thoroughly revised and considerably amplified. Explanations relating to the principles of technical processes have been included in general chapters, and do not in this edition occur under the special sections.

OUR ASTRONOMICAL COLUMN.

THE PLANET MARS.—In No. 360 of the *Observatory* Mr. Wesley discusses the photographs of the planet Mars which Mr. Lowell recently published. Mr. Wesley has made a very careful study of the six prints, and has been able to distinguish easily, on one or another of them, the features named by Mr. Lowell. He is not, however, prepared to corroborate the opinion expressed by the latter that the photographs confirm the fact that the so-called "canals" are *continuous lines*, for imperfect definition might render a row of dots as an unbroken line. As the Lowell photographs are too small to reproduce satisfactorily, Mr. Wesley has made a composite drawing showing all the features seen on any of the prints, and this is given as a frontispiece.

In the same journal Mr. Denning gives, among other planetary observations, an account of his recent areographical researches with a 12½-inch Calver reflector, using a power of 300. He is very certain of the actual existence of the features termed "canals," many of which he was able to identify quite easily. He regards "canals," however, as an unfortunate designation for the irregular, frequently knotted streams of shading, which are by no means straight or narrow, but have a perfectly natural appearance, and says:—"The idea that they are clearly cut lines, suggestive of artificial origin, may be dismissed as a mere conjecture unsupported by reliable evidence."

Major Molesworth, of Trincomalee, Ceylon, has recently communicated to the Royal Astronomical Society a record of his observations of Mars during the opposition of 1903. These observations were made, under excellent conditions, with a 12¾-inch Calver reflector, generally employing a power of about 450. An abstract of this paper, giving the principal tables and conclusions, appears in No. 8, vol. lxv., of the *Monthly Notices*, accompanied by six beautiful drawings showing the chief characteristic features of the Martian surface during the opposition. As his results testify, Major Molesworth has made a long and laborious study of this planet with great zeal, and he has not the slightest doubt as to the reality of the "so-called canals." These markings do not, however, appear to him as continuous definite lines, but rather like "streaky" lines such as would be drawn on very rough paper with a rounded crayon or stump. He records several instances of gemination, and offers a natural explanation of the phenomenon. On six occasions he observed projections either on the limb or the terminator. In conclusion, he proposes a new classification of Martian features, and discusses the several "contrast" and "illusion" theories which have been opposed to the reality of the "canals." Likening these peculiar markings to those seen on Jupiter, he concludes that if the latter be accepted as real—as they undoubtedly are—then the similar ones on Mars cannot, on any logical basis, be ascribed to illusion.

THE RINGS OF SATURN.—Observing at Aosta (Italy) during the later months of 1904, MM. Amann and Rozet noted a novel feature on Saturn's rings. On October 20 M. Amann saw a sharp, accentuated marking, or shadow, on the rings some distance from the outer edge of the shadow cast by the planet itself, and having a curved form concave towards the planet. Between October 20 and November 15 this new feature was not seen, although numerous observations were made under favourable conditions. After November 15 the shadow was seen repeatedly, and it was then noticed that that part of it which was projected on the inner ring was always broader and more accentuated than the other part. Between December 22 and 27 it was seen that this broader portion was bifurcated, so that the whole shadow had the form of a capital Y; that the apparition was a shadow was shown by its fixed position relative to the planet, notwithstanding the rotation of the latter and its rings (*Bulletin de la Société astronomique de France*, August).

DECLINATIONS OF CERTAIN NORTH POLAR STARS.—In No. 3440 of the *Astronomische Nachrichten* Dr. Auwers pointed out that in certain hours of right ascension, north of declination +82°, there were gaps containing no "fundamental" stars, and asked that these gaps might be filled. In answer to this request Miss Harriet Bigelow, of the Smith College Observatory (University of Michigan), has determined the places of twenty-one stars situated between declinations +84° 34′ and +88° 55′, and now publishes them in vol. vii. of the *Proceedings of the Washington Academy of Sciences* (pp. 189–249). The instrument employed was the Walker meridian circle, having a telescope of 6·3 inches aperture and a focal length of 8 feet.

THE MINOR PLANET OCLLO (475).—Another set of positions of the interesting asteroid Ocllo, as determined by Mr. R. H. Frost at Arequipa, are given in Circular No. 103 of the Harvard College Observatory. The object was re-discovered on, and its position determined from, a plate taken on June 6, and was also shown on other plates secured on June 7 and 9. The determined positions show that Ocllo seems to be about 4° from its position as computed from the previously published elements. The data now given, together with the positions published in Circulars Nos. 63 and 101, should enable the elements of Ocllo's peculiar orbit to be determined with great accuracy, and to insure against the future loss of this planet.

THE ROYAL UNIVERSITY OBSERVATORY OF VIENNA.—We have just received vols. xv. and xviii. of the *Annalen der k.k. Universitäts-Sternwarte in Wien*, edited by the director, Prof. E. Weiss. Vol. xv. contains a catalogue of 2417 stars the places of which have been determined by Herr F. Bidschof with the meridian circle, and are given for the mean equinox of 1885·0. The instrumental equipment and the methods employed in the reduction are discussed at length. A series of observations of Jupiter made between February 20 and May 1, 1898, by Herr J. Rheden is also described in this volume, and the description illustrated by fifty coloured drawings of the planet, which are given on the two accompanying plates.

Vol. xviii., in the first part, is devoted to the results obtained from the observations of minor planets and comets, made by Dr. J. Palisa with the Grubb refractor of 67 cm. (about 27 inches) aperture during the years 1899–1901. The observations of seven comets and four nebulæ are included, and the whole of the results are tabulated at the end in a handy form for reference. This volume is completed by the meteorological results obtained in 1901, 1902, and 1903, the pressure, temperature, &c., being given for 7 a.m., 2 p.m., and 9 p.m. on each day.

THE STATE AND THE CLAYWORKER.[1]

IT is the purpose of each of these works to supply the members of the clay industry, in the State to which it refers, with an account of the geological relationships, the mode and place of occurrence, and the chemical and physical properties of the raw clays both worked and unworked. The manufacturing processes of various types of ware are also described as they are practised in the State, with numerous details of physical tests that have been applied to them.

The subject has been treated upon very similar lines in both reports; the Iowa volume, however, contains more information upon the practical manufacturing side; it devotes a chapter to the selection and upkeep of power plants, and has a fuller account of different forms of kiln; there is even a section dealing with the composition of the fuels used in burning the clays. But this volume

[1] "Clays and Clay Industries of Iowa." By S. W. Beyer, G. W. Bissell, I. A. Williams, J. B. Weems, and A. Marston. Iowa Geological Survey, vol. xiv. Pp. xi+664. (Des Moines: Iowa Geol. Survey, 1904.)

"The Clays and Clay Industry of New Jersey." By H. Ries and H. B. Kümmel, assisted by G. N. Knapp. Geological Survey of New Jersey, vol. vi. Final Report. (Trenton, N.J.: Geological Survey of New Jersey, 1904.)

suffers somewhat in comparison with the New Jersey one through faulty editing; there are many more diagrams in the former than in the latter work, but they are sometimes too small for the matter they contain (p. 572); they are rather untidy in appearance, and are frequently inserted sideways in the text when they should be upright. The chemical portion is unnecessarily duplicated, and the important table of analyses (p. 344) is rendered useless for ready reference by the complete omission of silica.

Both books are provided with maps of the geological distribution of the clays, with abundant photographic illustrations of varying degrees of value, with a directory of the clayworkers in the State, and fairly numerous references to the literature of the subject. In each case the section dealing with pottery is weak.

Prof. Ries still maintains that the most generally useful way of expressing the chemical nature of a clay is through the ultimate analysis, though he admits the value of the so-called "rational" analysis in the case of the higher grade clays; with this view we are entirely in accord. Messrs. Beyer and Williams appear to lean somewhat towards the "rational" analysis, and have given the results in this form along with the ultimate analysis—a useful custom. Their method of dividing the ultimate analysis into "sand and clay," "total fluxes," and "moisture, CO_2 and SO_3," is convenient. The influence of titanium on the fusibility of clay is rightly emphasised by Ries; in this country it has been very generally neglected in analyses.

The physical tests applied to clay products were:—compression tests, transverse tests, absorption tests, and freezing and thawing (Iowa only); of these, the second is held in highest esteem; it is certainly far superior to the crushing test in most cases, but we are among those who do not agree with Prof. Marston that for *paving* brick it can take the place of the "rattler" test; the objections he urges against the latter may be applied with equal force to the former, while he admits that the action of the "rattler" approximates more closely to the kind of wear to which paving bricks are subjected in actual use.

From a multitude of councillors we expect wisdom; it is none the less true that if the councillors will not consult one another we are apt to get only confusion. Everyone who publishes some results of physical tests of clays and clay wares seems to think that these should become recognised standards at once. The two authorities here cited are no exception; each one stoutly believes that its own favoured methods should be adopted for general use. There is here a satisfactory unanimity as to the kind of test required, but when we come to details of application, we find considerable divergence of practice in precisely those points which together go to constitute a standard test.

Thus in obtaining the modulus of rupture in the "transverse" test of bricks, New Jersey employs rounded knife-edge contacts alone, while Iowa interposes steel bearing-plates between the brick and the knife-edges; in the crushing and absorption tests New Jersey uses half a brick, Iowa grinds out from the brick a 2-inch cube; again, the former measures linear shrinkage and calculates the cubic shrinkage, the latter reverses the process, using a Seger volumeter for the purpose. For estimating texture (fineness of grain) Iowa employs a modification of Whitney's method, New Jersey uses a centrifugal apparatus. Further, there is an important difference between the methods of collecting materials; Prof. Marston asks for a fairly large consignment to be sent by the manufacturer, and tests twenty or more bricks in the transverse way; on the other hand, members of the New Jersey Geological Survey staff pick out five to seven representative bricks on the spot, and send them to be similarly tested by Prof. Ries. Useful though these tests may be for local reference, it is evident that a standard series of tests will never be arrived at by such isolated endeavours; indeed, we cannot help feeling that in these and similar publications there is much duplication and waste of energy through the lack of a little coordination.

There will be diversity of opinion as to the expediency of the State taking upon itself the task of publishing tests of manufactured wares; it stands in the same relationship to producers as to consumers, yet, while such publications may be supposed to benefit the latter class uniformly, a considerable injustice might conceivably be done to one of the former the ware of which took a lower place in the scale. This danger is exemplified to some extent in the Iowa report, which mentions the names of firms in conjunction with the results, and the effect is too much like an advertisement. New Jersey adopts the plan of publishing the laboratory number of the test; the manufacturer has the result communicated to him privately. For our part we doubt the wisdom of such publication, except upon lines similar to those on which watches and thermometers are tested in this country.

But good maps of the distribution of the clays, the preparation and collection of comparable data of the physical and chemical properties of the *raw* materials, experiments on the results of blending hitherto unworked clays with one another and with known clays, and the coordination of the information and samples in a manner accessible to all, is the legitimate duty of a State department, and of the utmost value to all sections of the community.

The Geological Surveys of Iowa and New Jersey have performed most of these duties in a manner which cannot fail to be appreciated. When we remember that in addition to this Geological Survey work there is in each State a well equipped ceramic laboratory for testing and for instruction in the manufacture of all grades of wares—the department of ceramics in the State College of New Brunswick has an outfit in the brick-making section capable of turning out 20,000 bricks per day—we are constrained to turn our eyes to our own State, where we see the capital pioneer effort of an individual, George Maw, nearly fifty years ago—and what beside? "Comparisons," as Mrs. Malaprop says, are "obvious."

THE CEREBELLUM: ITS RELATION TO SPATIAL ORIENTATION AND LOCOMOTION.[1]

As the cerebellum is well represented in the lowest vertebrates and undergoes relatively little change in form with the higher development of the rest of the brain, it must be regarded as a fundamental structure of the vertebrate nervous system. This may be one of the reasons that much interest has centred in its study and in the attempt to define its functions in exact physiological terms. Though Willis (Oxford, 1660) noted the intimate connection between the cerebellum and pons Varolii, and recognised that the trapezial fibres of the latter are a cerebellar and not a cerebral system, and though Majendie laid the first foundations of our knowledge of its functions, it has only been of recent years that we have gained, chiefly from the work of Luciani and the workers who followed him, satisfactory insight into its anatomy and physiology.

In the lecture, Sir Victor Horsley analysed the conclusions on its functions which have been obtained by the destruction and stimulation methods of study, and in addition contributed from his clinical and laboratory experience some facts which help to elucidate the *rôle* it plays in our nervous economy.

In the first place all recent work confirms the conclusion formulated years ago by Edinger, that the cerebellum is essentially an organ for the reception of certain sensory impulses. Systems of fibres ascending from the spinal cord convey to it part of the sensory impulses which enter through the dorsal roots from the cutaneous and more deeply placed peripheral nerves. These tracts of fibres end in the cerebellum exclusively in its vermis or middle lobe. To the vermis also come direct root fibres of the vestibular nerves which collect from the semi-circular canals, the organs of the special sense of orientation in space, the sensations of change of position and of the position of the head in space. The lateral lobes of the cerebellum, on the other hand, are in connection through the pontine grey matter with the temporal lobes and with the kinæsthetic cortex of the forebrain. All these systems which conduct to the cerebellum end in its cortex, and

[1] Abstract of Boyle Lecture delivered by Sir Victor Horsley, F.R.S., before the Junior Scientific Club of the University of Oxford, June 5.

from the latter—and this is a new fact of great significance—no true efferent fibres arise. The efferent or motor mechanism of the cerebellum is contained in its nuclei, the system of roof nuclei being in connection with the cortex of the vermis, the nucleus dentatus with that of the lateral lobe. The cortex of the cerebellum is thus the special organ for the reception of sensory impressions, while its nuclear system may be regarded as its motor or efferent mechanism.

The functions of the cerebellum must be studied in relation to the sensory impressions it receives and to the activity of other centres. While it is the cortex of the forebrain which consciously appreciates and records our sensory impressions and initiates purposeful actions, it is the cerebellum which automatically preserves our equilibrium, guides our locomotion, and assists to regulate our finer movements. Thus its functions are in part reflex or involuntary, dependent on the sensory impulses which reach it directly or through the forebrain, and in part to coordinate and regulate the muscular contractions generated in the kinæsthetic cortex, especially those which result in movement in space and those on which the maintenance of equilibrium depends. The accuracy of equilibration is necessarily dependent on our knowledge of our position in space. This is obtained chiefly by vision, but as our visual fields are small in relation to the space in which we exist, sight must be supplemented by the power to turn the head and eyes in the three planes of space. There is conclusive clinical and experimental evidence that the coordinated execution of these movements is largely represented in the ponto-cerebellar centres. The sense of touch is also a valuable aid in spatial orientation, for though by touch the body can be aware only of the surface with which it is actually in contact, we can explore, as blind men do, our neighbourhood by the movements of our limbs. The memory of space so obtained is stored up in the kinæsthetic cortex, and disease of this region diminishes or destroys our knowledge of points on the surface of our body so far as their precise position in space is concerned, and consequently the effective movement of the limb. It has been long recognised that one of the most prominent signs of destructive lesions of the cerebellum is the inability to move a limb in a coordinate manner towards any point, but it appears probable from some not yet concluded observations of the lecturer that the faculty of localisation of points of the body in space is also defective with disease of the cerebellum. The touch sensations from the portions of our body resting on our base, the pressure sensations in our joints, and the sensations of tension in our muscles are also requisite for the automatic maintenance of equilibrium. These are some of the sense impressions which pass to the cortex of the vermis by the anatomical tracts referred to.

It would appear that the cortex of the vermis receives the sensory impressions necessary for movement in the anterolateral plane and for bending backwards and forwards; with lesions of this part there is a tendency to fall forwards or backwards. The lateral lobes, on the other hand, receive through the middle peduncles, as Majendie demonstrated, the stimuli necessary for rotation on the longitudinal axis.

From the cortex of the cerebellum, which is constantly receiving these waves of sensory impressions, the cerebellar nuclei collect the properly associated impulses which regulate and reinforce the purposeful movements and the automatic actions of the individual.

This latter position has been established by the researches of Dr. Clarke and the lecturer during the past three years.

Luciani's discovery that the cerebellum is also a source of energy to the muscles, which become asthenic and hypotonic on its destruction, is also fully confirmed by the lecturer's own work.

In conclusion, this sketch of the cooperation of the cerebellum and cerebrum was illustrated by a quotation from Boyle, who said:—"I consider the body of a living man not as a rude heap of limbs and liquors but as an engine consisting of several parts so set together that there is a strange and conspiring communication between them."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Melbourne has received a largely increased endowment from the Government of Victoria on condition of instituting a course for a degree in agriculture. The necessary arrangements for such a course have now been made, and the university is inviting applications in England and America for a professorship of botany and a lectureship in biochemistry in connection with the school of Agriculture. A new professor of anatomy is also to be appointed for the rapidly growing medical school.

THE Drapers' Company has made a further grant of 5000*l*. for an extension of the premises of the East London Technical College. In addition, the company has largely developed its scholarship scheme. Next year nineteen scholarships will be awarded of the value of 40*l*. per annum, tenable at the college for three years. Certain of these scholarships are reserved for women, while others will be awarded in the subjects of the London arts degree. The governors of the college have extended the work by introducing a course in languages and literary subjects. Students taking this course will study under recognised teachers, and be internal students of the University of London. As a consequence of this development, the governors have decided that the college shall, in future, be known as the East London College.

PROBATE has been granted of the will of Mr. John Innes, of Merton, Surrey, who died on August 8, 1904, leaving the sum of about 200,000*l*. for public and charitable purposes. Among other bequests he left his house, the Manor Farm, Merton, and two acres of ground, "to establish thereon a school of horticulture or such other technical or industrial institution as the law will allow, to give technical instruction in the principles of the science and art of horticulture and the necessary physical and mental training incidental thereto; to erect suitable buildings and furnish them, and to provide workshops, tools, plant, scientific apparatus, libraries, reading-rooms, lecture and drill halls, a swimming bath, and gymnasium. If this may not be legally carried out, then to establish in these buildings a public museum for the exhibition of collections of paintings and similar works of art, objects of natural history, or of mechanical or philosophic inventions, and to lay out land for a park."

MR. S. HERBERT COX has been appointed to the professorship of mining at the Royal School of Mines, South Kensington, vacant by the death of Sir Clement Le Neve Foster. In view of the changes in organisation that may be found desirable in the Royal College of Science and the Royal School of Mines after the completion of the investigations now in progress by the departmental committee, the appointment has been made a temporary one. Mr. Cox is an Associate of the Royal School of Mines. After experience as assistant geologist and inspector of mines in New Zealand, he was appointed instructor in geology, mineralogy, and mines in Sydney Technical College; concurrently with his tenure of this office he was employed to give technical lectures at various mining camps in New South Wales, and practised as a mining engineer. Since 1900 he has been entirely engaged in private practice, and has had experience of mining in England, France, Spain, Egypt, the United States, and Canada. Mr. Cox was president of the Institution of Mining and Metallurgy in 1899–1900.

THE *London University Gazette* (August 9) publishes the following announcement referring to the endowment of a chair of protozoology:—"The senate had before them a communication from the Secretary of State for the Colonies, offering the university the sum of 700*l*. a year for five years for the purpose of instituting a chair of protozoology. Of this sum, 200*l*. a year was stated to be a contribution from the Rhodes trustees, and 500*l*. a year to represent a moiety of a grant originally made from the tropical diseases research fund (established under the auspices of the Colonial Office) to the Royal Society for the promotion of research work, and by the Royal Society surrendered for the purpose of endowing the chair. Having considered reports upon this offer from the academic council, and from the board of advanced medical studies and the boards of studies in botany and zoology, the

senate decided to accept the offer, to devote the whole of the 700*l.* a year as salary to the professor, and to set aside a further sum of 200*l.* a year to defray the cost of assistants and laboratory expenses in connection with the chair."

A day higher commercial department is to be opened at the end of September next in connection with the City of London College. The object of this department is to provide a higher education for those who have already had an ordinary secondary education. Hitherto there has been some basis for the charge that higher education has not generally induced students to regard business sympathetically, nor has it exhibited a commercial career attractively. Those engaged in higher education have seldom attempted to show that the study of science, language, and of other subjects is, or can be, related to the conduct of commerce, and that a commercial man will understand his business better if he starts with a groundwork of knowledge which has been deliberately exhibited to him in its relation to the conduct of ordinary business. Those responsible for the new scheme at the City of London College believe that, other things being equal, a youth who has been trained to see the principles which lie behind the facts of commerce, to know how far nature has been controlled by commerce, and commerce by nature; to know the commercial methods of his own and other nations and the reasons for their existence, will make a better business man than one who has had no such training. They believe that there is a mass of experience a judicious selection from which, if assimilated, will save an English youth on his actual entry to commercial life from errors and waste of time. The experiment will be watched with great interest by all who are interested in the various sides of higher education.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 8.—"The Morphology of the Ungulate Placenta, particularly the Development of that Organ in the Sheep, and Notes upon the Placenta of the Elephant and Hyrax." By R. **Assheton.** Communicated by A. Sedgwick, F.R.S.

The formation of the placenta of the Ungulata vera is founded on a system of foldings of the subzonal membrane (or of the trophoblast only), which fit into corresponding grooves in the walls of the uterus, without thickening of the trophoblast layer of the blastocyst, and without destruction of maternal epithelium or other tissue (Sus). Certain parts of the crests of the ridges are produced by local amplification into true villi, into which the splanchnopleure of the allantois subsequently extends (Equus, Bos, &c.).

For this type of placentation, which is caused fundamentally by the folding of the trophoblast, the term plicate is used (placenta plicata), and to this type of placentation it is suggested that the Cetacea, Sirenia, and Proboscidea conform, as well as the Ungulata vera, and possibly the Edentata and Prosimia.

The term placenta cumulata is used for the type of placentation in which the placenta is formed by the heaping up or thickening of the trophoblast layer, among the cells of which accumulation extravasated maternal blood circulates. Destruction of the maternal epithelium probably always occurs. To this type belong the Rodentia, Insectivora, the Hyracoidea, Primates, and Chiroptera. The Carnivora are perhaps intermediate, but, according to Strahl's account, they would be distinctly plicate, while, according to the account of other authors, they are slightly cumulate.

The morphological position of the sheep's placenta, a full account of the development of which is given in the paper, is at that end of the series of plicate forms which closely approximates to the cumulate type.

The placentation of the Ungulata shows that that order is more closely connected with the Proboscidea, and the Sirenia and Carnivora, than with other groups of mammals, whilst the placentation of the Hyracoidea suggests no connection at all with those groups, but is of the cumulate type, and resembles more closely the form found in certain of the Insectivora.

Edinburgh.

Royal Society, July 10.—Dr. R. H. Traquair in the chair.—On the bathymetry, deposits, and temperature of the south-western Pacific: Sir John **Murray,** K.C.B. The region discussed lay to the east and south-east of Australia. Seven of the soundings were in depths exceeding 4000 fathoms and three in depths exceeding 5000 fathoms. Interesting comparisons were made between the bathymetric charts and the temperature charts, and information was also derived from the study of more than 1000 samples of deposits. Globigerina ooze covered about 48 per cent., and red clay about 44 per cent. of the bottom, the remaining 8 per cent. being covered by other deposits. The percentage of carbonate of lime was low in very deep water and in shallow water near islands not bordered by coral reefs. In moderately deep water and in shallow water where the deposit was coral mud, the percentage of carbonate of lime was high. The evidence seemed to point to a continent in the making rather than to a sunken continent.—The varying form of the stomach in man and the anthropoid ape: Prof. D. J. **Cunningham.** The paper was a detailed discussion of the anatomy of the stomach, its changes of form and position at various stages of digestion, the functions of the different parts, and the movements by which digestion was carried out.—The evaporation of musk and other substances: John **Aitken.** The question was as to the nature of the exhalation or emanation which produced the characteristic odour; was it solid or vapour? The test applied was the cloud-producing power in a region saturated with water vapour and suddenly cooled. Experiment showed that when the air was purified of dust particles, but full of musk emanations and water vapour, a sudden cooling produced no cloud. Therefore the emanation must itself be vapour and not solid. The same result was obtained with many other substances, such as spices, chemicals, herbs, and flowers, not one of them giving off solid particles. Evidence was adduced that the dusts of these substances affected the branch of the fifth nerve which serves the nostrils, while the olfactory nerve was sensitive to matter in the gaseous form.

July 17.—Lord McLaren in the chair.—On some points in the geometry of reflecting telescopes with graphical solutions: Dr. James **Hunter.** The real problem in the construction of an efficient reflecting telescope is to find the best size of small mirror and the best position for it, so that the maximum of light and of definition is gained. This the paper discussed in detail, and gave a simple graphical construction by which the required data could be obtained to an approximation sufficient for practical purposes.—Some general principles of absorption spectrophotometry, and a new instrument: James R. **Milne.** The necessary conditions for the photometric comparison of two patches of light, of which one is produced by a ray passing through an absorbing medium, were fulfilled as follows:—(1) By use of a small hole instead of a slit in the collimator a strictly parallel beam of light was secured. (2) By use of a naked flat acetylene flame, the beam was obtained of equal intensity across a normal section, a condition unrealisable by electric arc or lime-light unless heavily screened. (3) By means of a double image prism replacing the ordinary eye-piece of the spectrophotometer telescope it was found possible (*a*) to bring the two patches of light presented to the eye accurately edge to edge, (*b*) to have these patches of some width, namely, that of the telescope objective, (*c*) to secure the coplanarity of the two "faces" of rays which proceed from each point of the edge common to the two patches. The instrument constructed on these lines could also be used as a spectrometer or as a spectropolarimeter for measuring optical rotations.—Note on some generally accepted views regarding vision: Dr. W. **Peddie.** The note referred to some observations on the effect of fatigue in the eye in relation to its power of judging of colour.—On the opacity of aluminium foil to the ions from a flame: George A. **Carse.** The experiments were made in the Cavendish Laboratory, and showed that the aluminium foil was quite opaque to the ions, a result not in agreement with results described by Lebon.—On deep sea-water waves: Lord **Kelvin.** This was a continuation of a paper read last January. By use of Lord Rayleigh's method of

ultimate intersections, a correct diagram was obtained of ship waves in deep and broad water, an approximate representation of which had been given in 1887 (see "Popular Lectures and Addresses," vol. iii.). The numerical calculations and drawings were made by Mr. J. de Graaff Hurster.—On the periods and nodes of Lochs Earn and Trieg: Prof. **Chrystal** and E. Maclagan **Wedderburn.** This was a detailed comparison of the observed periods and nodes with those calculated from the hydrodynamical theory as already given by Prof. Chrystal. The bottom contours were approximated to by piecing together appropriate parabolic functions of the depth; the results of theory and of observation were in good agreement, especially as regards the periods, which are less influenced by local conditions than the node-positions or the amplitudes.—A regular fortnightly exploration of the plankton of the two Icelandic lakes, Thingvallavatn and Myvatn: C. N. **Ostenfeld** and Dr. C. **Wesenberg-Lund.**—Note on the boiling points of solutions: S. N. **Johnson.** It was found that the boiling-point elevation constant C, as calculated from the formula

$$Cw\{1+(n-1)a\}=mWe,$$

where m is the molecular weight of salt used, W the weight of solvent, w the weight of salt added, α the ionisation constant, n the number of free ions, and e the observed elevation of temperature, had widely differing values. The discrepancies clearly arose from the difficulty of getting the boiling point of the solvent. When, however, C was calculated from the formula when for e and w are substituted the increments Δe and Δw, as one passes from solution of lower to solution of higher concentration, satisfactorily concordant results were obtained. The salts studied were the nitrate, chlorate, chloride, and bromide of potassium, and the nitrate and chloride of sodium.—The oxidation of manganese by persulphates: Dr. Hugh **Marshall.**—Influence of cross magnetisation on the relation between resistance and magnetisation in nickel: Dr. C. G. **Knott.** The decrease of resistance of a strip of nickel foil when magnetised transversely to its length was numerically increased when the foil was set in a steady magnetic field magnetising it longitudinally, while the increase of resistance accompanying the application of this longitudinal field was numerically decreased when the foil was set in a steady field magnetising it transversely.

PARIS.

Academy of Sciences, August 7.—M. Bouquet de la Grye in the chair.—Observations of the planet Y.R. (Goertz) made with the large equatorial of the Observatory of Bordeaux: E. **Esclangon.** Observations of this planet were made on July 29 and 30, and the results are given, together with the mean positions of the comparison stars, and the apparent positions of the planet.—On the sidereal day: A. **Pansiot.**—On continued algebraic fractions: M. **Auric.**—On similitude in the motion of fluids: M. **Jouguet.**—On the state of matter in the neighbourhood of the critical point: C. **Raveau.** A criticism on a recent paper on the same subject by MM. G. Bertrand and J. Lecarme. The author contests the views put forward by these authors, and notes that a consequence that they have deduced is a peculiarity of which a complete account is rendered by the ordinary kinetic theory of gases.—On magnetic double refraction. Some new active liquids: A. **Cotton** and H. **Mouton.** A solution of dialysed iron prepared by the method of Bravais undergoes a marked change when heated for some time at 100° C. The double refraction in a magnetic field became greater, four hours' heating making the double refraction forty times its original value; the size of the particles was clearly increased by the heating. Colloidal solutions of iron were also prepared by the method indicated by Bredig for the precious metals. This solution was doubly refracting also, but the variation with the strength of the field followed a different law to the Bravais solution. A solution of iron prepared by the Bredig method in glycerine was also examined. Solutions were also found exhibiting magnetic double refraction which did not contain iron, but minute crystals of calcium carbonate. Reason is shown for supposing that for these effects to be observed the size of the separated particles must lie between certain limits.—On the chloroborates of calcium: L. **Ouvrard.**—Study of the constitution of unsymmetrical dipara-ditolylethane, of the dihydride of 2:7:9:10-tetramethylanthracene and of 2:7-dimethylanthracene: James **Lavaux.**—On the absorption spectrum of manganous salts: P. **Lambert.** The manganese salts used in the research were purified with especial care from iron, since the spectrum of the latter element in the ultra-violet was found to interfere. A diagram is given of the manganese bands for wave-lengths between 557 and 394.—The thermochemistry of the hydrazones: Ph. **Landrieu.** The reaction between some ketones and aldehydes has been determined directly in the calorimeter, and the values thus found compared with those deduced from the heats of combustion determined with the Berthelot bomb. The results of the two methods show a fair agreement.—The mechanical properties of iron in isolated crystals: F. **Osmond** and Ch. **Frémont.** The experiments were made upon crystals of a volume of several cubic centimetres, and included measurements of the extension, compression, hardness, and bending. It was found that the mechanical properties of iron in crystals are a function of the crystallographic orientation. The fragility, very great in the plane of cleavage, is, contrary to the views generally held, associated with great plasticity in the other directions.—The classification and nomenclature of the arable earths according to their mineralogical constitution: H. **Lagatu.**—On the reddening of the vine leaf: L. **Ravaz** and L. **Roos.** A study has been made from the chemical standpoint of the non-parasitic reddening of the leaf of the vine. The results confirm the theories of Bœhm and some other authors on the solution and migration of the carbohydrates in the leaf.—*Sterigmatocystis nigra* and oxalic acid: P. G. **Charpentier.** Oxalic acid is a product of the growth of this mould when cultivated in Raulin's solution, and is still produced when the tartaric acid of this solution is replaced by sulphuric acid. But if the Raulin's solution is deprived of sugar, and the tartaric acid is the only source of carbon, then oxalic acid is not formed.—On the mending of wounds in cartilage both from the experimental and histological points of view: V. **Cornil** and Paul **Coudray.**—On accommodation and convergence in binocular vision: Léon **Pigeon.**—The geological structure of the central Sahara: Émile **Haug.**

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THURSDAY, AUGUST 24, 1905.

SCHOOL MATHEMATICS.

Easy Graphs. By H. S. Hall, M.A. Pp. vii+64. (London: Macmillan and Co., Ltd., 1905.) Price 1s.

The Rudiments of Practical Mathematics. By A. Consterdine, M.A., and A. Barnes, M.A. Pp. xv+332. (London: John Murray, 1905.) Price 2s. 6d.

Elementary Practical Mathematics. By H. A. Stern, M.A., and W. H. Topham. Pp. viii+110+viii. (London: George Bell and Sons.)

A First Algebra. By W. M. Baker, M.A., and A. A. Bourne, M.A. Pp. x+176+xxxv. (London: George Bell and Sons, 1905.) Price 2s.

Algebraical Grounding. By D. E. Shorto, M.A. Pp. 46. (London: Rivington, 1905.) Price 1s. net.

Examples in Algebra. By Charles M. Clay. Pp. vii+372. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1905.) Price 4s. net.

Geometrical Conics. By G. W. Caunt, M.A., and C. M. Jessop, M.A. Pp. vi+80. (London: Edward Arnold.) Price 2s. 6d.

THE little book on "Easy Graphs," by Mr. H. S. Hall, is the result of ripe experience, and is intended to lead the beginner by very easy stages and show him all the points that require special attention in squared paper work and the lessons to be learnt therefrom. Great attention is paid to the suitable choice of scales and the proper figuring of the diagrams. Linear graphs with inferences and applications occupy fully half the book, the latter half relating to algebraical equations and graphs of the second degree with one or two cubics. The numerous examples are interesting and suggestive, and all the answers are given at the end. We agree with the author in deprecating the undue employment of graphs, especially as the field in which they may be legitimately used is sufficiently extensive. The book will be deservedly popular.

The "Rudiments of Practical Mathematics," by Messrs. Consterdine and Barnes, is a very excellent treatise, intended more particularly for students above twelve years of age who are preparing for industrial pursuits. The heuristic method is in the main followed, and the material for exercises is largely drawn from the students' own measurements, suitable objects of a simple kind being provided for this purpose, with appliances for measuring lengths, areas, volumes, weights, and times. Thus every rule and process is definitely associated with some direct quantitative application, and the subject assumes a real and living interest and cannot fail to be assimilated. The subject-matter is purposely confined to that which is in daily use in industrial occupations, so that there is time for this to be dealt with in a very thorough manner. In this volume arithmetic, algebra, and geometry are so interwoven that any attempt at separation would appear quite unnatural. Thus when an important principle, say that of proportion, is under review it can be studied and developed with the completeness which its importance demands, arithmetically, algebraically, and geometrically. Students are taught the use of logarithms, and also sufficient trigonometry to enable them to solve right-angled triangles; they use compasses and setsquares, draw simple plans and elevations, and make dimensioned free-hand sketches in pictorial or other projection, and they are introduced to the notion of a vector by means of displacement and velocity diagrams. In some places there may be an insufficient number of examples for the purposes of drill, but altogether the subject is admirably developed and presented; the book is well adapted to its purpose, and its wide adoption would have a very beneficial effect.

The "Elementary Practical Mathematics," by Messrs. Stern and Topham, is a preliminary volume comprising the first nine chapters of a more complete text-book on which the authors are engaged. It relates to physical measurement with exercises based thereon, including the measurements of length, angles, mass, area, volume, specific gravity, with the practical calibration of certain glass vessels. The two first chapters deal with contracted arithmetical processes and squared paper work, but otherwise a knowledge of "theoretical" mathematics is assumed. The work is intended as a first course for the junior forms of schools, and especially for boys preparing for army examinations. The apparatus is fairly comprehensive, and the experiments are well described. The book will be very useful to those arranging a course in an important branch of practical mathematics.

The "First Algebra," by Messrs. Baker and Bourne, is adapted from the first part of the authors' larger work, and, proceeding in the customary order, carries the subject up to quadratic equations and fractional and negative indices. Arithmetical and graphical illustrations are freely introduced, and a special feature of the work is its very easy graduation and the large number of examples, some oral, provided at every stage, so that students using the book properly cannot fail to obtain a full knowledge of the subject. The answers are completely given, and themselves extend to thirty-five pages. The book gives an admirable first course in algebra.

Mr. Shorto's "Algebraical Grounding" is a collection of the definitions, axioms, laws, rules, and proofs belonging to the subject, without examples, and arranged in logical sequence. It is intended as a summary of the oral teaching usually imparted, and could well be used in conjunction with a collection of examples. It includes logarithms, the progressions, and the binomial theorem.

The collection of eight thousand "Examples in Algebra," by Mr. Clay, has been accumulating for the last twenty years, during which time the author has been engaged in teaching the subject in America, and has found that the examples provided in the ordinary text-books are deficient in both quantity and variety, and not regularly graded. The teacher will here find examples in superabundance, increasing in difficulty by almost insensible steps from the simpler

exercises in the use of symbols to the difficult problems in surds, theory of exponents, quadratics, and in arithmetical and geometrical progressions. The work shows no trace of having been influenced by the reform movement going on in this country, but teachers will receive valuable hints and much useful matter by consulting this thorough and extensive compilation.

The "Geometrical Conics" by Messrs. Caunt and Jessop is a preliminary deductive course for students about to enter on a systematic study of analytical geometry. Only the leading properties of conics are dealt with, and these are established when possible from corresponding properties of the circle by the aid of the modern methods of projection. The book is well suited to its purpose.

PANAMA CANAL.

Problems of the Panama Canal. By Brig.-General Henry L. Abbot, U.S. Army. Pp. xi+248. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1905.) Price 6*s.* 6*d.* net.

THE author of this book acquired distinction in hydraulics in early life by the publication, in conjunction with Captain Humphreys, of their well-known "Report on the Physics and Hydraulics of the Mississippi River" in 1861; and, accordingly, this statement of the problems of the Panama Canal, in which hydraulics are so largely involved, by such a high authority, who, as a member of the technical committee of the New Panama Company, devoted seven years to their study, deserves the most careful consideration of the American nation, for whose guidance this volume has been published. It appears at a very opportune time, when the United States Government has undertaken the completion of the works, but has entrusted to a commission of engineers the consideration of the precise designs for the canal.

The chapters on the "New Panama Company," with which the author was connected, "The Rival Routes" of Panama and Nicaragua, the "Physical Conditions of the Isthmus," "The Chagres River," with its torrential floods and difficulty of control, and the "Disposal of Rainfall," all present features of interest, and the last three are essential in a study of the works to be carried out; but undoubtedly the most interesting portion of the book for the British public and engineers generally is contained in the final chapter on "Projects for the Canal." It will be remembered that when M. de Lesseps started the scheme about twenty-five years ago he proposed the construction of a tide-level canal; and the works were commenced on this basis with very inadequate investigations of the nature of the strata to be traversed by the cuttings, especially through the Culebra ridge, and the physical conditions of the locality. When experience had proved the unexpected magnitude of the undertaking, and the unforeseen difficulties to be overcome, the original company, approaching the end of its resources, decided in 1887 to introduce locks, thereby greatly reducing the amount of excavation, and also the time required for the completion of the canal. Eventually, after the failure of the first company, a New Panama Company was formed in 1894 (given by a misprint as 1904 in the introduction); and the works for a canal with locks were slowly proceeded with as funds permitted, until at length, last year, the United States Government purchased the undertaking with the view of carrying it out as a national work. Early this year an engineering committee of the Panama Commission recommended a sea-level canal again, with a bottom-width of 150 feet and a minimum depth of 35 feet, and the necessary duplicate tidal locks near the Panama end, capable of accommodating vessels up to 1000 feet in length and 100 feet in width.

The principal objections to the formation of a canal across the isthmus at sea-level throughout, are the time, difficulties, and cost involved in making a cutting, reaching a depth of 317 feet, in unfavourable strata exposed to tropical rains, and the efficient control of the River Chagres, which crosses the line of the canal on the Atlantic slope in several places, and the floods of which will become a more serious peril to the maintenance of the canal in proportion as the water-level of the canal is lowered. The objection of cost, and, to some extent, that of time, are of considerably less importance in a national than in a private undertaking; but the floods of the Chagres appear liable to prove a standing menace to the safety of a tide-level canal. The Isthmian Canal Commission of 1899–1901 expressed its disapproval of a sea-level project in the following words:—

"The cost of such a canal, including a dam at Alhajuela, and a tide lock at Miraflores near the Pacific end, is estimated at not less than 240,000,000 dollars. Its construction would probably take at least twenty years. This Commission concurs with the various French Commissions which have preceded it, since the failure of the Old Company, in rejecting the sea-level plan. While such a plan would be physically practicable, and might be adopted if no other solution were available, the difficulties of all kinds, and especially those of time and cost, would be so great that a canal with a summit level reached by locks is to be preferred."

The author regards these remaining difficulties as very important; and, after discussing them, and particularly the problems concerning the control of the Chagres, he concludes his book with the following expression of his opinions:—

"It is the unanimous opinion of all the engineers who have had practical experience in canal work, and time to thoroughly study the problem, that no sea-level *projet* without locks, and no sea-level canal, even with a tidal lock, is practicable that would be comparable in ease and safety of transit to one equipped with modern locks, and planned to take advantage of all the desirable elements which the natural conditions offer. Why, then, waste an extra ten or a dozen years, and untold millions of dollars, to execute a scheme which the investigations of thirty-five years have demonstrated to possess only a sentimental merit due to the imagination of M. de Lesseps? Congress and the American people are impatient for the opening of the best possible canal."

OUR BOOK SHELF.

The American Thoroughbred. By C. E. Trevathan. (American Sportsman's Library.) Pp. ix+495; illustrated. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1905.) Price 8*s.* 6*d.* net.

FROM the point of view of the naturalist, the interest of this volume (which is no doubt an admirable guide to everything connected with racing on the other side of the Atlantic) is concentrated on the author's remarks with regard to the origin and development of the American thoroughbred. As a matter of fact, the racehorse in America has been produced mainly from an English ancestry, and is thus essentially of the English type; and the one matter for regret in his treatment of the subject is that the author does not appear to point out any features by which the American breed may be distinguished from its European prototype, as it is difficult to believe that minor differences between the two do not exist. The first thoroughbred imported into America seems to have been Bulle Rock, a horse foaled in England in 1718 and landed in Virginia in 1730. He was a scion of the Darley Arabian, and had also the blood of the Byerly Turk on the maternal side. The product of native-bred mares (that is to say, mainly the descendants of horses imported by the Spanish conquerors, which were themselves largely of Barb blood) by Bulle Rock formed the first foundation of the modern American racing stock. Diomed was another famous English stallion imported into Virginia in the old days; but long after the definite establishment of an American thoroughbred stock, considerable improvement was effected therein by the importation in 1836 of Glencoe, at that time a renowned English horse. Glencoe was by Sultan, and while in England sired Pocahontas, the dam of Stockwell, Rataplan, and King Tom, the three greatest sires the English turf has ever seen, and to one of which almost every living English racehorse can trace descent. With such a sire the future of the American thoroughbred was assured. In conclusion, we may congratulate the author on having added a valuable volume to a valuable library, as well as on having made an important contribution to our knowledge of the ancestry of the American racehorse.

R. L.

The Story of Reptile Life. By W. P. Pycraft. Pp. 212. (London: George Newnes, Ltd., 1905.) Price 1*s.*

THIS is a valuable addition to the "Newnes' Library of Useful Stories." Mr. Pycraft not only writes in a readable and entertaining style, but also has the happy faculty of selecting precisely those facts which enable him to expound general principles. The "Story of Reptile Life" is not an elementary book of natural history in the ordinary sense, but the outline of a really scientific treatise which is not too technical to be understood by a beginner. After some introductory remarks explaining that he has to deal with a race "whose glory has departed," the author proceeds to describe each of the groups of surviving reptiles, with some reference to their immediate ancestors as revealed by fossils. In each chapter he treats first of the most salient points in anatomy, and then proceeds to select a few of the more important living species for detailed notice. The account of the existing reptiles is followed by two chapters on domestic life and reptilian liveries. The book then concludes with chapters on the extinct flying reptiles, land reptiles, and sea reptiles. We have detected no serious errors, though it is difficult to accept all the author's speculations concerning some of the extinct forms, and there are more misprints than ought to be. The book also lacks adequate illustrations. It is, however, a worthy sequel to Mr. Pycraft's earlier "stories" of birds and fishes, and we hope he may soon complete the series by a final volume on the mammals.

Digest of the Evidence given before the Royal Commission on Coal Supplies (1901–1905). Vol. i. Pp. lxiv+474. (London: The *Colliery Guardian* Co., Ltd.) Price 21*s.*

THE *Colliery Guardian* has done useful work in preparing this digest of the evidence given before the Royal Commission on Coal Supplies. The 25,662 questions and answers contained in the official minutes of evidence do not constitute an attractive form of technical literature; but with the matter rearranged and classified under separate heads, and the interrogative converted into the narrative form, it is surprising to find what an enormous amount of valuable information has been got together. With the exception of a brief historical introduction, no comment is made on the evidence, and such additions as the witnesses have found desirable when revising their evidence have been printed as footnotes. The work will be completed in three volumes, the subjects dealt with in the first being the working of thin seams, the limit of depth in mining, waste in working and coal-cutting machinery. There is a good index and a useful bibliography of the subjects discussed. Printed in large type, with the illustrations admirably reproduced, the work forms a valuable companion to the official Blue-books, and, indeed, from the point of view of the mining student, may replace them altogether.

Wasps, Social and Solitary. By George W. Peckham and Elizabeth G. Peckham. With an introduction by John Burroughs. Pp. xv+311; illustrated. (London: Constable and Co., Ltd., 1905.) Price 6*s.* net.

THIS book is founded on a series of papers published some years ago by the Wisconsin Biological Survey under the title of "Instincts and Habits of the Solitary Wasps," with much new matter added. It is a record of very patient field observations on the lines with which Fabre's well-known "Souvenirs Entomologiques" (constantly referred to, and compared by our present authors with their own) have made us familiar.

The wasps discussed are chiefly those which provision their nests with caterpillars and other insects, or with spiders; and the genera noticed are Vespa, Ammophila, Sphex, Rhopalum, Odynerus, Aporus, Crabro, Bembex, Cerceris, Philanthus, Trypoxylon, Pompilus, Tachytes, Chlorion, Pelopœus, Astata, Oxybelus, &c., all of which (Sphex, Bembex, and Chlorion excepted) include British species. Many persons are interested in the habits of insects who have not time or opportunity to observe them for themselves, and to all such we heartily commend this important work on the manners and customs of North American wasps.

W. F. K.

X-Rays: their Employment in Cancer and other Diseases. By Richard J. Cowen. Pp. viii+126. (London: Henry J. Glaisher, 1904.) Price 2*s.* 6*d.* net.

THE author of this work states in his preface that he has made no effort to summarise all the valuable work which has been done in radiotherapy, and he has only tried to select such part as seems to him to be most likely to assist those practitioners in the therapeutic

properties of X-rays, the choice of apparatus, and the technique.

In the first twenty-four pages the apparatus is considered, and the remainder of the work, with the exception of two short chapters, is devoted to brief consideration of a number of skin affections, including malignant disease. The book will certainly be of service to those for whom it is intended, and many practitioners who desire to become acquainted with this new branch of electrotherapeutics will find it a useful introduction. The work is well written and unpretentious, and Dr. Cowen has succeeded in the aim laid down in his preface.

Neue Abhandlungen über den menschlichen Verstand. By G. W. v. Leibniz. Translated, with introduction, by C. Schaarschmidt. Second edition. Pp. lxviii+590. (Leipzig: Dürr'sche Buchhandlung, 1904.) Price 6 marks.

Immanuel Kant's Logik. By G. B. Jäsche. Third edition. New edition by Dr. W. Kinkel. Pp. xxviii+171. (Leipzig: Dürr'sche Buchhandlung, 1904.) Price 2 marks.

Lazarus der Begründer der Völkerpsychologie. By Dr. Alfred Leicht. Pp. 111. (Leipzig: Dürr'sche Buchhandlung, 1904.) Price 1.40 marks.

THE first two of the above-mentioned works appear as parts of the excellent "Philosophische Bibliothek." The translation of the Leibniz into the philosopher's native tongue appears to be all that could be desired, and the introduction gives an analysis of the work. We gather that some 460 explanatory notes are to be found in the succeeding volume of the series. This edition of "Kant's Logik" is intended to supersede the uncritical one of Von Kirchmann, who relied only on the second Hartenstein edition of 1868. The present editor has gone back to the original text of Jäsche, and has also compared the other important editions, the first Hartenstein and the Rosenkranz, both of 1838. The spelling is completely modernised. Prof. Moritz Lazarus was, with Steinthal, the founder of the *Zeitschrift für Völkerpsychologie und Sprachwissenschaft* in 1859, and his works not only contain much sound psychology, but are also permeated by a fine ethical spirit. His long life and labours are here described by a singularly appreciative disciple.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

British Fruit Growing.

THE question of "the diversity of yield from farms in the same neighbourhood" to which you referred in your article on the report of the fruit committee is, as Mr. Alfred Walker remarks, one of very great complexity. No evidence on this subject, however, was offered to the fruit committee by the numerous growers who appeared as witnesses before them, and it would certainly seem to be a subject more suited for investigation at an experimental station than one which could be dealt with by a departmental committee.

Meteorological conditions are, no doubt, primarily responsible for most failures of cropping, and, in a climate such as that of our islands, we can never hope to do more than mitigate the evil effects of inopportune cold. The destruction of the blossoms is generally due—as in 1903—to cooling by radiation, and the best safeguard against this form of cooling is a fairly elevated position, and a lie of the ground favourable to the draining away of the cold air from the plantation. Good air drainage is probably more important in fruit growing than good water drainage. Various means have been investigated for producing radiation by artificial means, but the results have not yet proved themselves to be successful, at any rate from an economic point of view.

The destruction of blossoms, however, is caused sometimes by a low atmospheric temperature produced by means other than surface radiation. This was the case in the present year, when the destructive cooling agent was a cold wind. A warm, low situation, with plenty of shelter, will afford some safeguard against damage from such a source; and these, unfortunately, are just the conditions which will increase the danger from radiation frosts.

There is no doubt, however, that the damage done by a low temperature is not always done in a direct manner. A continued spell of cold weather at the blossoming season is inimical to the activity of the various insects on which pollination mainly depends, and we are not yet in a position to say that a sluggish action of the roots and leaves may not itself be directly detrimental to the process of fertilisation. The number of apples and, still more, of pears which have been imperfectly fertilised, and have, therefore, dropped prematurely, have been very noticeable this year.

What part the nature of the soil plays in modifying the action of cold on the trees is one which is very difficult to foretell or to determine. We can never have two plantations in different soils while being in exactly similar positions; and the question whether a blossom will be reduced to a lower temperature by radiation in the moist air overlying a clay soil than it would be in the dryer air overlying a gravel soil, or whether, if reduced to the same temperature in both cases, it would suffer more in the one than in the other, is a question on which we cannot dogmatise. We must not be misled by the feeling of cold experienced in two such cases by the human subject; indeed, watering the trees and ground is one of the methods suggested for obviating the effects of radiation frosts. Differences of soil, also, will act indirectly in the matter by affecting the root-action and the forwardness of the blossoms.

On one point, however, I think there can be no doubt, namely, that the best safeguard against injury by frost, where frost is inevitable, is a healthy condition of the tree itself. It has been a matter of continued observation that with similarly situated plantations, and with similar trees in the same plantation, those which are most healthy will nearly always suffer least from frost. It is specially noticeable that with trees which are weakly, even when they carry (as will often happen) a great abundance of blossom, injury from frost is very severe, although the abundance of blossom should be favourable to some of these being preserved from destruction.

It is in this direction—the general health of the trees and the raising of healthier and hardier varieties—that success in diminishing loss by frosts will most probably be achieved. It is hardly probable, I think, that much will be effected, at any rate in the case of apples, by raising varieties blossoming late enough to escape frosts. These frosts, as we all know, often occur very late in the year, and though every day by which the blossoming is retarded must, on the average, diminish the risk of its destruction, there would appear to be but little chance of our being able to retard it sufficiently to diminish that risk to any material extent. It must be remembered, also, that though we might raise a late blossoming apple, it is a hundred chances to one that the fruit would be able to compete in the market with known varieties.

The flowers of the large majority of English apples would appear to open within a period of about ten days. Observations made this year on 117 varieties gave a total range of 16 days, but 98 per cent. of these varieties opened within a range of 13 days, and 84 per cent. within a range of 9 days. The extent of the variation, therefore, is not sufficiently large to offer much promise of success in raising a variety which would escape frost by its lateness of flowering. It is noticeable, however, that our English apples appear to be rather earlier in their flowering than varieties belonging to other countries, when all are grown under the same conditions. The results obtained at Woburn this year were as follows, the dates being those of the opening of the first flowers, and the fractions of dates arising, of course, through the taking of the means. The number of varieties under observation are given, and

those termed English include several varieties of foreign origin which are commonly grown in England. In most cases the trees were on the crabstock:—

117 English	May 6·4
36 Scotch	May 8·9
9 Irish	May 9·4
8 French	May 9·0
(1 German	May 4·0)
7 Russian	May 8·6

Another point of some interest in connection with these results may be mentioned, namely, that there is a connection between the earliness of blossoming and the earliness of the ripening of the fruit, though it is so slight that it becomes apparent only when the averages of a considerable number of varieties are taken, and many individual instances may be noticed where the later fruit follows the earlier blossoming:—

37 Early varieties	May 4·7
40 Mid-season varieties	May 6·3
40 Late varieties	May 8·0

This letter, I fear, is already too long, but it leaves unmentioned several points which may be of importance in determining the fruiting of trees.

SPENCER PICKERING.

Artificial Diamonds.

OF the two phases, diamond and graphite, diamond is the denser, and has also the less internal energy. It follows that, if carbon can be crystallised at comparatively low temperatures, the minimum pressure sufficing to determine the diamond form will be lower than that employed in M. Moissan's experiments.

For estimating the transformation temperature corresponding to low pressures, the data available are incomplete; it is here suggested, however, as a tentative result from experiments which are still in a preliminary stage, that the transformation temperature corresponding to atmospheric pressure lies somewhere between 550° C. and 700° C., or not far outside those limits, temperatures having so far been judged only by eye.

A molten alloy of lead with about 1 per cent. calcium appears to be capable of holding in solution some small proportion of carbon, which exists either as free carbon or as calcium carbide; and if the calcium is eliminated from the molten mass, some carbon crystallises out. Steam, for example, converts the calcium into hydrate without attacking the lead. If the reaction has occurred at a full red heat, graphite is found in the crust of lime; if only a very low red heat has been attained, no graphite is found, but a number of very small or microscopic crystals, which have many of the properties of the diamond. The illustration is from a pencil drawing of a very minute crystal, viewed under a magnification of 80 diameters, and drawn on a greatly enlarged scale.

FIG. 1.—Supposed diamond from lead-calcium-carbon solution.

The crystals obtained exhibit mostly faces of the octahedron, modified by the cube and dodecahedron; in no case has any internal flaw or lack of perfect transparency been detected in them. The refractive index is clearly very high, and an attempt to determine it by displacement of focus gave 2·43 (instead of 2·47), any convexity of the refracting surface tending to give too low a value. The crystalline faces are, in fact, generally if not always convex, in many cases strongly so. The crystals adhere tenaciously to clean, dry glass; they are unacted upon by ordinary acids (hot or cold), by cold hydrofluoric acid, and by fused alkali at a red heat. When strongly heated on platinum foil, they burn away, leaving no residue. The quantities at present available are too small for the ready determination of density or hardness.

Negative results were invariably obtained in control experiments on the commercial calcium carbide which was used in preparing the alloys.

Tin may be used in place of lead, but it is freely oxidised by the steam, and the resulting dioxide is troublesome to get rid of. Of other reactions which appear to have yielded minute crystals of diamond, the following may be mentioned:—boiling benzene or toluene in contact with finely powdered potassium dichromate or with concentrated aqueous solution of gold chloride; heating benzene or toluene mixed with carbon tetrachloride or chloroform to 200° C. to 300° C. in a bomb. In the last named reactions, nearly all the carbon separates out in the amorphous form, hydrochloric acid collecting under enormous pressure.

I hope shortly to return to the subject of these experiments, and to make a fitting acknowledgment of my deep indebtedness to Mr. W. J. Hartley, to Messrs. Neville and Heycock, and to other friends.

C. V. BURTON.

4 Chesterton Hall Crescent, Cambridge, August 19.

The Spread of Injurious Insects.

IN 1898 Dr. L. O. Howard forwarded to me a scale insect discovered by Prof. Chaves at Ponta Delgada, Azores, attacking the foliage of the orange tree. The insect proved to be new, and was described as *Lecanium perlatum*. Since that time it has never been reported from any other place; but now I have received some large, flat, dark brown scales on orange leaves from Villa Encarnacion, Paraguay, collected by Mr. Schrottky, and they are this very same *L. perlatum*.[1] This is only one new case to be added to the many already known of scale insects being transported from one side of the world to the other, evidently by human means. It is to be regretted that the British Government, with its numerous tropical colonies and excellent botanical gardens, has not done something to make known the scale insects within its domains. It is true that Mr. E. E. Green, the Government entomologist of Ceylon, is bringing out a magnificent work on the scale insects of that island; but he finds insufficient support, and it is divulging no secret to say that the publication of this useful book will involve him in very serious financial loss. There is no properly classified national collection of scale insects (the only good collection in England is that of Mr. Newstead at Liverpool), and we are still totally ignorant of the coccid fauna of many colonies. The reasons for regretting this condition of affairs are mainly two:—(1) because in ignorance pests of this group are continually being carried to new regions, where they are liable to become destructive; and (2) because man is so mixing up the distribution of these insects that every year makes it more difficult to ascertain their natural habitats. Having regard for the experiences of the past, it is surely safe to say that the annual expenditure of a few hundred pounds in the investigation of these pests would be far more than repaid in economic as well as scientific gains.

T. D. A. COCKERELL.

University of Colorado, U.S.A., August 10.

A Parasite of the House-fly.

I SHOULD like to direct attention to an interesting parasite of the house-fly which is in this district extremely abundant this summer. The creature is, as a rule, very hard to find, and many thousands of flies may be caught in ordinary seasons without a single parasite being found upon them. The animal in question is one of the *Pseudo-Scorpionides* (? Chelifer), easily recognisable by its pair of long chelæ, and I should be glad if any of your readers would inform me to what genus it belongs and whether it is equally abundant this year in other places.

Eton, August 19.

M. D. HILL.

[1] In my original description, it is stated that the skin is not reticulated. The new material shows that it is minutely reticulated or tessellate in the middle of the back. The antennæ, described as 8-jointed, vary to 7-jointed, with the fourth joint longest, but the third nearly as long.

MORE LIGHT ON ANCIENT BRITAIN.[1]

IT is gratifying, and at the same time puzzling, to find that the antiquities discovered in part of a single county can provide material for two such voluminous works as Canon Greenwell's "British Barrows" of 1877 and the record of Mr. Mortimer's researches, now issued with the assistance of Mr. Sheppard, the energetic curator of the Hull Municipal Museum. The district investigated lies between York and Bridlington, and teems with relics of the past, most of the barrows, or burial mounds, dating from the Bronze Age, but two or three cemeteries containing Anglo-Saxon graves at least a thousand years later. The excavations in which the author has been concerned for so many years are well described; but those without special knowledge of the period will turn with most satisfaction to the introduction, where, with the aid of copious extracts from the earlier work already mentioned, some interesting generalisations are made from the data furnished by the spade. Evidence is brought forward in favour of cannibalism among the ancient Britons, a practice that has been suspected for some time; and human sacrifice, perhaps also suttee, seems to have been indulged in at the burial of an important personage. In some barrows there were signs that a circular hut or a pit-dwelling had been used as a sepulchre, the walls and roof being thrown down over the body; and the author's suggestion as to the

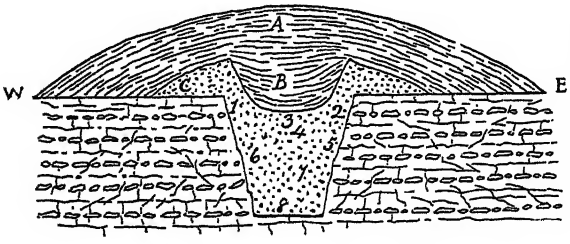

FIG. 1.—Section of Round Barrow, Aldro, E.R. Yorks.

origin of the incomplete ring formed by stones or a trench round many burials of the period is certainly plausible. In his own words, "these rings are probably marks of taboo or enclosures which were made at the beginning of the ceremony to mark off and protect the sacred spot in which the ceremony and interment were afterwards to be conducted, and the break in the circle had no other significance than to serve as a place of ingress and egress during the performance of the obsequies."

It is interesting to have existing evidence as to the sepulchral pottery confirmed by further discoveries. With a few very doubtful exceptions the so-called "drinking-cup" is never found with calcined human bones, and generally accompanies the primary, or at least one of the earliest burials, in the mound or the grave beneath it. Of the "food-vessels," 43 were found with cremations and 119 with unburnt skeletons; and these figures agree with Canon Greenwell's, giving a proportion of about one to three. Though occasionally found on the top of calcined bones, the cinerary urns, as their name implies, were generally used to contain the ashes of the dead, and "incense-cups" are invariably associated with the rite of cremation, though we must contest the statement that the latter vessels are also found in Scandinavia, Germany, France, and even the Troad.

The intricacies of the text are considerably simplified by numerous diagrams, giving the plan and vertical section of the barrow under examination, and a specimen is here reproduced to show how it is possible to read the history of a burial mound. One in the Aldro group measuring 84 feet in diameter and 5 feet in height was excavated in 1866. The clay and soil forming the upper part is marked A, while B is a boat-shaped mass of clay and soil below it, C being the chalk filling of the inner mound and grave below the original surface-level EW. Nos. 1–8 are interments of children and adults in a pit cut rather deeper than usual in the chalk rock; but they were not all complete skeletons, No. 7, for instance, being a heap containing a "drinking-cup" in 48 pieces, fragments of six human lower-jaws, and a number of small bones packed in an adult calvarium. Whether contemporary or not, these burials had been surmounted by a dome of chalk which was cut into for another burial at some later date and subsequently covered with the outer mound.

Of the succeeding Early Age of iron remains are few in this particular district, though abundant a few miles further north; but one burial of importance must be noted. The swords here illustrated were found with a skeleton, and belong to two distinct types; the longer is of usual dimensions and has the characteristic curved scabbard-mouth and the chape of the middle period of La Tène, while the shorter sword is the only one of the kind known to have been found in this country, and with similar examples from France and Switzerland may date from about 100 B.C. The human head between the branches of the pommel is evolved from the knob that appears in that position on certain short swords from the Hallstatt cemetery.

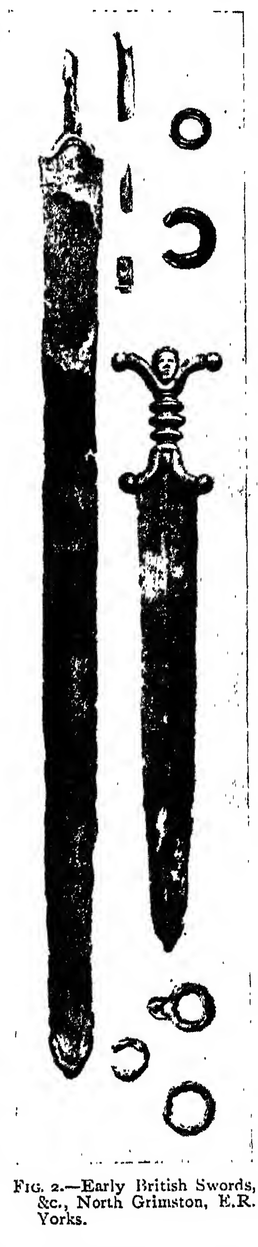

FIG. 2.—Early British Swords, &c., North Grimston, E.R. Yorks.

The Anglo-Saxon cemeteries contain unburnt bodies of which the orientation is instructive, while many excellent brooches and other relics have been recovered. These and the vast Bronze Age series have been amply and creditably illustrated, but, ungallant as it may appear, a protest must be lodged against the frontispiece, which gives a totally false impression of the Grimthorpe sword. In a work containing so many references misprints are excusable, but some are irritating; thus, Inverary (p. 361)

[1] "Forty Years' Researches in British and Saxon Burial Mounds of East Yorkshire." By J. R. Mortimer. Illustrated by Agnes Mortimer. Pp. lxxxvi+452. (Hull: A. Brown and Sons, Ltd., 1905.)

should be Inverury, and the next page has a cruel mutilation of Le Gros Guignon, while the reference to *Archaeological Journal* on the page before should be to the York volume (1848).

Following an excellent example, Mr. Mortimer furnishes relic-tables with all necessary details at the end of the volume, together with a copious index. Comparison with Canon Greenwell's table shows a very large proportion of primary interments, there being in one case as many as seventeen, to three secondary; but in a matter of this kind different conclusions might be drawn from the same data. Altogether the work is most welcome as a fund of material for more general treatment, and should encourage the study and publication of prehistoric finds in England.

THE FORTHCOMING TOTAL SOLAR ECLIPSE.

BY the time that NATURE appears next week, the total solar eclipse of August 30 will have become an event of the past, and we hope then to be in a position to announce that the careful preparations, which have occupied the minds of astronomers for so many months past, have been crowned with success.

Since the appearance of Dr. Lockyer's article concerning the eclipse, in our issue of February 23, several important modifications in the proposed arrangements have been made, but most of the eclipse observers are now at their stations erecting or adjusting their instruments for the final scene on Wednesday next. How much depends on the nicety of these adjustments can only be understood by those intimately concerned; but when it is recalled that since the general introduction of photographic methods into eclipse work the sun has only been eclipsed for about half an hour, that the duration of totality in the coming event exceeds 3¾ minutes, and that no favourable opportunity will occur again until 1912, when totality will only last for about 60 seconds, some idea may be obtained of the anxiety of those observers who are fortunate enough to take an active part in next Wednesday's observations.

Subjoined to this article is a letter from Dr. W. J. S. Lockyer describing the preliminary operations of the eclipse expedition of the Solar Physics Observatory, under the personal direction of Sir Norman Lockyer, K.C.B. When all arrangements for this expedition were nearly completed, but before Sir Norman Lockyer left England, it was decided by the French Government, in quite a friendly spirit, that the presence of a foreign man-of-war in Philippeville harbour was not desirable at the present time; therefore arrangements were made with the Spanish authorities, who rendered such valuable help to the similar expedition in 1900, for the party to go to Palma. Some of the work contemplated at Palma is described by Dr. Lockyer in his letter.

Some novel observations will be made by other observers. In a recent communication to the British Astronomical Association Mr. C. E. Stromeyer pointed out that geodesy might be assisted by an accurate determination of the path of totality. This path has been computed on the assumption that the earth has a certain form, and if the computed values are found to be incorrect, the errors in the assumption might be discovered. Another valuable suggestion was made in a letter from Dr. Johnstone Stoney which appeared in these columns on July 13, wherein the writer pointed out that the planet Mercury will be very near to a line joining the earth and the sun, and will therefore present a very thin crescent to the observer's view. If Mercury has an atmosphere, the horns of the crescent should appear prolonged by atmospheric refraction, and a careful observer, suitably equipped, should be able to detect the prolongation, and possibly to observe the spectrum of the tips.

M. Touchet suggests that the moon might be observed, both before the first and after the fourth contacts, projected on the brighter portions of the lower corona, by an observer employing a suitable dark glass with a small telescope.

In a brochure recently received from Señor Horacio Bentabol, of Madrid, the author makes a number of suggestions to eclipse observers by which the existence of a lunar atmosphere might be detected. Among other matters he suggests that delicate thermometric observations made for some hours before and after the eclipse might exhibit a heat-absorption effect due to the interposition of the lunar atmosphere, between the sun and the observer, before the actual body of the moon was interposed. Solar radiation observations might also exhibit the same effect. Photometric observations of the illumination of the sky might show an analogous absorption of light, due to the lunar atmosphere. Exact determinations of the solar diameter would, if the moon possesses an atmosphere, probably show the results of the refraction due to that atmosphere. The apparent hourly movement of the sun should become modified, as the lunar atmosphere is interposed, for the same reason. Many other points whereby the existence of such an atmosphere might be tested are given by Señor Bentabol.

As recently mentioned in these columns, French astronomy will be well represented at the various stations, whilst American astronomers have journeyed to a number of widely separated stations. Three expeditions have been sent from the Lick Observatory to Labrador, Spain, and Egypt respectively. At each station a search is to be made for an intra-Mercurial planet, and large-scale coronagraphs of exactly similar construction are to be employed. Should any actual movements take place in the corona during the two and a half hours which elapse between totality at Labrador and at Assouan, the photographs obtained at these respective stations should show it.

The Canadian Government has dispatched an expedition to Labrador, and has officially invited Mr. and Mrs. E. W. Maunder to accompany the same. Mrs. Maunder will employ a coronagraph exactly similar to that which Prof. Turner is using in Egypt.

The details concerning the regions crossed by the eclipse track, and the times of totality, &c., have already been given in many places, but the subjoined table giving the times and magnitude of the greatest phase in these islands may be of interest:—

	Eclipse begins d. h. m.	Greatest eclipse d. h. m.	Eclipse ends d. h. m.	Mag.
Greenwich	29 23 49	30 1 4	30 2 15	0·786
Edinburgh	29 23 44	30 0 55	30 2 4	0·724
Dublin	29 23 39	30 0 53	30 2 5	0·799

In the above table, which is taken from the *Companion to the Observatory*, the times are Greenwich Mean Time, which is reckoned from the previous mean noon, and the magnitude is given with the sun's whole diameter as unity.

The Solar Physics Observatory Eclipse Expedition.

Palma, August 18.

We have now been at Palma a week to-day, and are all thoroughly settled down, not only at the very excellent hotel in which we are located, but at the eclipse camp, which lies about a mile towards the north-west. We are a large party. There are

150 volunteers from H.M.S. *Venus*, including the captain and all the officers, and we ourselves total six, namely, Sir Norman Lockyer, Mr. C. P. Butler and myself, and three volunteer observers, Lady Lockyer, Mr. Howard Payn, and Mr. Frank McClean.

We arrived here on the morning of August 10, having transhipped at Gibraltar to H.M.S. *Venus* about noon on August 8. The arrangements for transferring the 110 packing cases from ship to ship were all that could be desired, an Admiralty lighter and tug being in readiness on our arrival. By five o'clock in the afternoon we were steaming away towards our destination, leaving behind us that great pile of rock, which eventually became a dim speck on the horizon.

Needless to say, the conversations in the captain's cabin, in the wardroom, and in many other parts of the ship were concentrated on eclipse matters, and this culminated in a lecture which I was requested to give to the whole available ship's company. The keenness displayed was universal, and the following day volunteers were called for to assist in the work for the eclipse, and, as I have previously mentioned, they now total 150. The same evening Sir Norman Lockyer gave a lecture, which increased, if possible, the keenness previously displayed.

On our arrival at Palma, which, by the way, is situated in a beautiful bay with an excellent anchorage, the ship was boarded by numerous officials after the customary salutes had been exchanged between the ship and the fort. Amongst those who came on board was our friend Mr. Howard Payn, who had preceded us in order to fix on a suitable site for our camp, to arrange for local labour and material, and to smooth things generally for us. The very admirable way in which this difficult and delicate task was accomplished by him in conjunction with Mr. Roberts, the British Consul at Barcelona, could not be surpassed, and all the members of the expedition are unanimous in singing their praises. For the expedition to Spain in 1900 Mr. Payn rendered a similar service, and on that occasion the arrangements he made were all that could be desired.

On the afternoon of our arrival at Palma, Sir Norman Lockyer and Captain Eyres, in the company of the British Vice-Consul, Mr. Bosch, paid some official visits, and afterwards the site selected by Mr. Payn was visited. This site is an ideal spot for a large eclipse camp, being sufficiently close to a landing stage for boats, walled in, and perfectly open for astronomical observations in all directions. The ground, which is private property, has been kindly lent by the owner for the purposes of the eclipse observations, and the members of the expedition are extremely grateful for the use of such an admirable camping locality.

Indeed, kindness itself has been displayed in every direction. All the authorities of the island have laid themselves out to supply anything that is required, and already these offers have been accepted in several ways.

On the early morning of August 11 work at the camp began in earnest. The tents, loaned to us by the War Office, were taken ashore and erected, and later in the day the packing cases were landed and carried by carts to the ground. Parties from the ship soon began to be acquainted with the contents of the cases they had so delicately handled, and by the evening the large wooden structure composing the dark room and the camera end of the prismatic reflector, and also the siderostats and cœlostat huts, were nearly all erected and covered. While this work was in progress, meridian lines were being pegged out and the positions for the concrete pillars fixed.

The erection of the piers for the instruments commenced on the following day, and so soon as these were completed the instruments which were to be placed on them were put together and set up.

At the time of writing (August 18, 10 p.m.) great progress has been made; most of the instruments are nearly erected, some are in approximate adjustment, while they are now all under canvas, the coverings having been set up in truly nautical style.

To gain some idea of the work undertaken, it may be mentioned that the larger instruments include a prismatic reflector of 76 feet focal length, a 6-inch three-prism prismatic camera, two coronagraphs (one 16 feet focal length) and an objective grating camera worked in connection with one cœlostat, a triple camera of 3-inch aperture and 12 feet focal length for photographing the eclipsed sun in colours, and a $3\frac{1}{2}$-inch coronagraph worked equatorially. Already each instrument has a party from the ship to assist in working it efficiently, and these are daily in the camp to render aid when necessary.

In addition to the above-mentioned assistants for the instruments, there are several other pieces of work which are being taken in hand. Thus the disc party has already erected discs of various sizes on imposing structures on the east side of the ground. Further, there are groups of observers for sketching the corona without discs, making star observations, recording the colours of the corona and landscape, observing the shadow-bands and sweep of the shadow, making meteorological observations, &c.

These and other parties are daily being drilled to render them as efficient as possible, and there is every hope that eclipse day will find them skilled and accurate observers.

We are, however, rather doubtful as to the kind of weather that will be experienced here on the eventful day. So far, the chances have been in our favour, but partially clouded skies are more common than one would like to see. A sharp thunderstorm broke over the town on the early morning of August 17, and rain fell in torrents. Fortunately there was no wind, and no damage was done. Those acquainted with the local weather conditions cheer us up by forecasting fine weather, but clouds are far more frequent than one would wish them, and the prospects are not nearly so good as they were in India in 1898 or Spain in 1900. In less than a fortnight's time our fate will be sealed.

In addition to our party, numerous other observers of different nationalities are taking or have taken up their stations in the neighbourhood of the town.

WILLIAM J. S. LOCKYER.

FIRST INTERNATIONAL CONGRESS OF ANATOMISTS.

THE first meeting of the Congrès fédératif international d'Anatomie was held in Geneva, and commenced on the morning of Sunday, August 6, by the opening of an exhibition of specimens and appliances illustrating recent progress in anatomy. The congress closed on the evening of Thursday, August 10, when three hundred members and adherents of the congress were entertained by the city of Geneva to an official banquet. The congress represented a conjoint meeting of the five leading anatomical societies—the Anatomical Society of Great Britain and Ireland, Anatomische Gesellschaft, Association des Anatomistes, Association of American Anatomists, and the Unione Zooligica Italiana. Almost every country was represented. Switzerland itself contributed more than 100 members, France 66, Germany and Austria 36, Great Britain

and Colonies 23, Italy 11, America 3, and other countries 16. The largest contributors to the proceedings of the congress, however, were the Germans; out of a total of 117 communications, 32 were made by them, 31 by the French, 18 by the British, 15 by the Swiss, 8 by Italians, 5 by Swedes, and 2 by Americans.

From every point of view the congress was a success. Anatomy is peculiarly susceptible of international treatment, the subjects for description and discussion being concrete and capable of direct demonstration. The language difficulty certainly hindered a free discussion on more than one occasion; for instance, on the second day, a speaker, after giving his communication in French, listened most attentively to a vigorous criticism in German, and, bowing profoundly, replied, "Je ne comprends pas l'allemand." With an agenda list overloaded with 117 communications, there was a grave risk of disorganisation. Thanks to the complete arrangements made by the committee of organisation, presided over by Prof. A. Êternod, of Geneva, and to the perfect arrangement of business by the president of the secrétariat, Prof. von Bardeleben, the proceedings of the congress made an even and steady progress. The success of the congress must also be ascribed to Prof. Nicholas, of Nancy, secretary of the French society; English members were indebted to Prof. Symington, president of the British society, and to Dr. Christopher Addison, its secretary. Each day's work was divided into two parts; the morning was devoted to papers, ten minutes being allowed for each communication, and three minutes to any member who wished to criticise; the afternoon was set aside for exhibition of new specimens and demonstrations of the material on which the communications of the morning were based, and this was by far the most instructive and profitable part of the day's work. The Swiss cow-bell, employed by the president of each day's proceedings (for the president of each society acted in turn as chairman) to warn the speaker that he had reached the limit of his allotted time, bound the members of the congress by a common sense of humour and materially aided the success of the meeting. In spite of the *entente cordiale*, the British anatomists associated more closely with the German than with the French members of the congress—an association determined, for the greater part, by the fact that the Germans were the superior linguists.

With so extensive a programme, it is impossible in a report such as this to do more than note the more outstanding communications. Making every allowance for prejudice of race, the first place, both in importance of results and excellence of technique, must be assigned to the contributions made by Prof. J. T. Wilson, of Sydney University, who placed before the congress the results of a prolonged investigation into the developmental history of ornithorhynchus made by his colleague and collaborator, J. P. Hill, and by himself. With the material now at their command they will be able to write a full and precise account of the development of the monotremes and throw a great deal of light on mammalian morphology. The photograph of an ornithorhynchus egg, in the eight blastomere stage, was shown. Most remarkable of all were the specimens and photographs showing the early developmental phases of the central nervous system. The medullary plates, instead of folding over at an early date to form the neural tube as in mammals generally, remain exposed on the surface of the embryo and thus give a superb opportunity of studying the processes of segmentation and differentiation of the central nervous system. The cephalic part of the central nervous system is seen at first not to be differentiated into three parts, viz., hind-, mid-, and fore-brain, but into two, a hind part, or archencephalon, and a fore part, or deuterencephalon, under which the notochord terminates. The archencephalon shows four or five sharply demarcated neuromeres in front of the neuromere connected with the facial nerve (prefacial neuromeres), but Prof. Wilson detects in some of them traces of a subdivision. There are three post-facial neuromeres. By using embryos of Perameles and Dasyurus to supply blanks in the ornithorhynchus series, Wilson and Hill were able to show that the neural crest forms at first a continuous hem on the lateral margins of the medullary plates. That part of the neural crest corresponding to the prefacial neuromeres undergoes, relatively to the rest of the neural system, an enormous growth forming a plate of cells which was mistaken by Selenka in other marsupial embryos for a mass of mesoblast. The neural crest connected with the facial segment forms the acoustic ganglion; that with the post-facial neuromeres the glosso-vagal ganglion, the rest of the crest becoming differentiated into spinal ganglia.

It is within the memory of even the younger zoologists that ornithorhynchus was regarded at one time as a toothless mammal; then came the discovery by Poulton and by Stewart that teeth were present but remained embedded in the gums. Prof. Wilson was able to demonstrate in his series of embryos the presence of two dentitions—the development and absorption of a milk dentition and the formation of a permanent dentition—that discovered by Poulton and Stewart. Thus ornithorhynchus, so far as its dentition is concerned, takes its place with diphyodont mammals. Further, it was shown that each cusp of the permanent molars is preceded by a separate milk tooth—a powerful argument in favour of the evolution of molar teeth by the concrescence of single-cusped teeth. Photographs were exhibited of a reconstructed model of the skull of a fœtal ornithorhynchus which shows many aberrant and puzzling features. Other contributions to the embryology of monotremes were made by Prof. Keibel, of Freiburg (models showing the development of the urogenital apparatus of echidna), and to the embryology of marsupials by Dr. Für Bresslau, of Strassburg (preparations showing the development of the pouch of *Didelphys marsupialis*).

Two papers on the agenda list, one by Prof. von Bardeleben, of Jena, entitled, "Die Homologie des Unterkiefers in der Wirbeltierreihe," the other by Prof. Gaupp, of Freiburg, "Die Nicht-Homologie des Unterkiefers in der Wirbeltierreihe," brought again into prominence that much-debated problem—the origin and nature of the mammalian lower jaw. Bardeleben maintained that the lower jaw of a mammal was strictly the same structure as that of a reptile, and produced, as evidence of his contention, mandibles of marsupials and of human fœtuses in which there could be traced lines somewhat similar to the sutural lines to be seen in the reptilian mandible. Prof. Gaupp's paper was a clear and vigorous denial of Bardeleben's contentions. In Gaupp's opinion the temporo-maxillary joint of mammals was a new joint formed between the coronoid process of the reptilian jaw and the squamosal, and quite different from the mandibulo-quadrate joint of reptiles. His conclusions were largely based on a consideration of the relationship of muscles and nerves to these joints. The new mammalian joint was formed in the insertion of the pterygoideus externus, the end tendon of which be-

came the interarticular disc, as can be seen in echidna. By means of a model he demonstrated the manner in which a new joint could be developed without leading to a disturbance of the function of mastication, thus leaving the quadrate to form one of the auditory ossicles (hammer). It must be admitted that Gaupp's theory explains the embryological phenomena, and clearly met with general acceptance by the members of the congress. Prof. Eugen Fischer, of Freiburg, pointed out that the theory explained the presence of cartilage which he had found in the developing coronoid and condylar processes of the jaw in the mole and apes. A model of an early developmental stage of the human mandible was shown by Dr. Alexander Low, of Aberdeen, who also demonstrated a special formation of cartilage, independent of Meckels, in the condylar and coronoid processes of the human jaw—facts in favour of Gaupp's hypothesis. In the opinion of the writer of this report, this vexed question is not yet settled, nor is it likely to be so long as anatomists seek to derive the mammalian from the reptilian type of mandible.

Ten communications dealt with the structure or development of nerve cells. One of these was a paper by Prof. A. Donaggio, of Naples, "Il reticolo neurofibrillare della cellule nervosa dei Vertebrata (con demostrazione di preparati microscopici)," which revealed the energy and fire which Continental anatomists can throw into their work. Prof. Ramon y Cajal, of Madrid, also brought to the congress specimens to demonstrate the direct continuity of the neuro-fibrillar network of the nerve cell with the dendrites on the one hand and the axon on the other. He had placed his microscopes and specimens on a window-ledge of a passage leading to the laboratory where Donaggio gave an enthusiastic demonstration to an intent circle of listeners. Cajal suddenly joined the circle and gave a direct contradiction to some statement of Donaggio. A lively scene followed; Cajal fetched his microscopes and specimens one by one from the passage and placed them impetuously before Donaggio. It was hard to ascertain the exact point in dispute, but it was subsequently discovered that it was a matter of thickness of section, Cajal maintaining that Donaggio's sections were too thin to demonstrate the relations of the neuro-fibrillar network of the nerve cell, while, of course, Donaggio regarded those of his opponent as too thick. The dispute was amicably settled by the discovery that both meant the same thing, namely, that the neuro-fibrillar network of the nerve cell was directly continuous with dendrites and axon.

The question of the development and regeneration of nerve cells again came up for discussion. Dr. John Cameron showed excellent photomicrographs of the developing optic and spinal nerve fibres in amphibians and birds which he believed to be both of central and peripheral origin. Optic fibres he regarded as direct prolongations from the nuclei of the retinal ganglion cells. Specimens were shown by Dr. Alfred Kohn, of Prague, demonstrating that the cells which go to the formation of a nerve, both fibre and sheath, are derived from the central nervous system—a histological confirmation of Harrison's clever experiment. Prof. Barfurth, of Rostock, produced the results of experiments on regeneration of nerve fibres made by C. F. Walter, and concluded that the axis cylinders could be produced by the cells of the nerve sheath.

Dr. George Streeter exhibited a series of models showing the development of the acoustic ganglion in human embryos. The cochlear ganglion is separated from the vestibular ganglion during development, and the association of the cochlear nerve with the nerve to the posterior ampulla is merely fortuitous; Dr. Giuseppe Levi, of Florence, gave an account of the various forms of cells found in the ganglia of the spinal nerves in developing pigeons. In another communication this author showed that ganglion cells vary in size with the size of the animal in which they occur; other cells are not affected by the size of the animal. Dr. E. B. Jamieson exhibited an excellent series of dissections of the brain, showing how various nerve tracts, usually seen only in section, can be demonstrated in their complete extent by means of scalpel and forceps.

Several contributions were made to our knowledge of blood corpuscles. Dr. T. H. Bryce gave an account of the development of the thymus gland in Lepidosiren, and showed that leucocytes were present before this gland was developed, and that, therefore, Beard's theory of the thymus being the primary source of leucocytes could not be entertained. Weidenreich, of Strassburg, traced the origin of all forms of white blood corpuscles from a common mononuclear cell, which was similar to, if not identical with, connective tissue corpuscles. With this conclusion Dr. Bryce agreed. Prof. Jolly, of Paris, described the formation of the mammalian red blood corpuscle by the gradual absorption and disappearance of the nucleus, not by an extrusion as is usually supposed. A research into the changes in the thymus gland which take place with age led Prof. Hammar, of Upsala, to conclude that the lymphoid tissue of that gland reached its maximum development in the years of puberty. Analogous results were obtained by Dr. R. J. A. Berry and Dr. Lack, of Edinburgh, regarding the development of the lymphoid tissue of the vermiform appendix. Using the average number of lymphoid follicles seen in sections of the appendix as an index of the development of the lymphoid tissue, they concluded that the maximum number (7) was found about the twentieth year, every subsequent decade leading to a decrease in the number of follicles.

Very few of the papers dealt with the naked-eye structure of the human body, or had a direct bearing on the problems which interest the surgeon or clinician—a very remarkable fact when one considers that the vast majority of the members of the congress are teachers of medical students. To this limited group of communications may be assigned the paper by Prof. Symington on the relations of the deeper parts of the brain to the surface and Prof. Cunningham's further observations on the form of the stomach, with special reference to hour-glass stomach. Papers belonging to this section were given by Chaine, Ledouble, Broman, Delmas, Gilis, Steida, and Poirier.

Contributions to physical anthropology were also few in number. Dr. Wright, of Birmingham, dealt with the characters of the men buried in the round barrows of Yorkshire, and found that they were identical with the men obtained from prehistoric graves in the neighbourhood of Fribourg, Lussane, and Berne. Englishmen of to-day are rather longer-headed than the men who were buried in the round barrows of Yorkshire, a fact which Dr. Wright explained by the invasion and intermixture of the long-headed Scandinavians with the men of the round barrow age. Prof. Eugen Fischer dealt with the deposit of pigment beneath the conjunctiva. It occurs in mammals generally, and in all primates and races of men save Europeans, in whom the sub-conjunctival tissue is free from pigment except under certain pathological conditions.

Some very remarkable specimens—showing exqui-

site technique—of the maturation stages in the ovum of the bat were placed before the congress by Prof. van der Stricht. Equally fine specimens, showing the manner in which the zona radiata is formed round the ripening egg of the rabbit, were shown by Regaud and Petitjean, of Lyons University. Their specimens showed that the zona radiata of the ovum is fibrillar in structure, and that the fibrils are arranged in an inner and outer zone. The fibrils are formed in the intercellular protoplasm in which the cells of the Graafian follicle are embedded. It will be thus seen that the zona radiata is not formed from, but deposited on, the ovum. Prof. Êternod, of Geneva, dealt with the manner in which the human ovum becomes implanted in the uterus, and the subdivision of the archenteron into the cavity of the amnion, the neurenteric canal and alimentary tract.

If one may judge from the nature of several contributions to this congress, there is a decided tendency to break down the barriers that separate the methods of the anatomist from those of the physiologist. Three communications dealt with results obtained by experiment on living animals. Prof. Sano, of Antwerp, by removing groups of muscles from the limbs and studying the subsequent changes in the motor cells of the spinal cord, sought to determine the position of the various motor centres in the cord. Prof. Tricomi, of Messina, used a somewhat similar method in investigating the paths of auditory impulses.

The members of the congress took part in the dedication of a monument to the memory of Prof. Hermann Fol, who set sail from Havre in his yacht, *l'Aster,* in the spring of 1892 to investigate the fauna of the Mediterranean. From the day he sailed until now not a single trace has been discovered of ship or crew. The members of the congress were lavishly entertained by Madame Fol. The congress placed a wreath on the bust of the Swiss physiologist Servetus, who discovered the pulmonary circulation in the sixteenth century, and was burned at the stake by Calvin because, so it is said, he denied the existence of the Trinity. A wreath was placed by the British section of the congress on the spot where he was burned, this gracious act being prompted by Prof. Dixon, of Trinity College, Dublin.

The congress was a social as well as a scientific success. An invitation from American anatomists to meet at Boston in 1907 was declined, as it was felt that at least a space of five years should intervene between each congress. A permanent committee for the organisation of the next congress was formed by the nomination of five men, one from each of the five affiliated societies. It is intended to bring out a bulletin containing the proceedings and transactions of the congress, to which purpose part of the sum (11,000 francs) raised by subscription in Geneva to meet the expenses of the congress will be devoted. When it becomes the turn of London to entertain this congress, it will not be found an easy matter to attain the standard of hospitality which has been set by Geneva.

PROF. T. R. THALÉN.

By the death on July 27 at Upsala of Prof. Tobias Robert Thalén, Sweden has lost one of her most eminent physicists and teachers. He conducted investigations of great delicacy and value in the field of spectrum analysis, and was the assistant of A. J. Ångström in much of his work. He also furnished valuable contributions to the knowledge of terrestrial magnetism, and devised ingenious methods of searching for iron-ore deposits. Born at Köping on December 28, 1827, he matriculated at the University of Upsala in 1849, where he graduated as Doctor of Philosophy in 1854. In 1856 he became lecturer on astronomy, and from 1856 to 1859 travelling scholarships enabled him to study in England, France, and Germany. In 1861 he was appointed assistant professor of physics at Upsala, and from 1869 to 1870 he was professor of physics at the Stockholm Technical School. In 1873 he was appointed professor of mechanics at Upsala, and in the following year was transferred to the chair of physics. This professorship he held until 1896.

The principal memoirs written by him dealt with the determination of lines in the solar spectrum (1860), researches on the magnetic properties of iron (1861), on the Fraunhofer lines (1866), spectrum analysis (1866), determination of the wave-lengths of metallic lines (1868), terrestrial magnetic observations in Sweden in 1869–71 and 1872–1882, researches on the spectra of metalloids (1875), the search for magnetic iron ore deposits (1877), and on the arc spectrum of iron (1885).

Prof. Thalén's researches on the spectra of metals and metalloids won for him wide renown, and are recognised as classical contributions to spectrum analysis. Partly in conjunction with Ångström and partly by himself he produced accurate and elaborate maps showing the wave-lengths of the lines in the spectra of many elements. He also made a careful examination of the absorption bands of iodine vapour, and engaged himself on the difficult problem of determining and properly assigning the lines in the spectra of bodies of the yttrium and cerium groups. At the period when these papers appeared, precise measurements were needed to settle several fundamental questions in spectrum analysis, and the researches in which Prof. Thalén took part were of great assistance in this connection. The revised list of the lines in the arc spectrum of iron, published in a memoir presented to the Royal Society of Upsala in 1885, is still a standard work of reference wherever investigations in spectrum analysis are carried on.

The magnetometer invented by Prof. Thalén for searching for magnetic iron ore deposits greatly facilitated the work of prospecting, and there is not a single iron mine of any consequence in Sweden where this instrument has not been used. It was described in a paper read by Mr. B. H. Brough before the Iron and Steel Institute in 1887. In appreciation of the value of this instrument, in 1874 the Swedish Association of Ironmasters awarded Thalén a gold medal; and in 1884 he received the Rumford medal of the Royal Society for his spectroscopic researches. He was a member of the Swedish Academy of Sciences, and an honorary member of numerous scientific societies, both in Sweden and other countries.

THE SOUTH AFRICAN MEETING OF THE BRITISH ASSOCIATION.

The various sections of the British Association met at Cape Town for three days last week, when presidential addresses were delivered and reports and papers were read and discussed. We print two more of the presidential addresses this week, and, following our usual custom, shall give in subsequent numbers other addresses, as well as reports of the proceedings of the sections written by members attending the meeting in South Africa. It is only necessary now, therefore, to refer to matters of general interest connected with the meeting.

On August 17 a special graduation ceremony in

honour of the association was held at the City Hall. The degree of Doctor of Science was conferred upon:—Prof. G. H. Darwin, F.R.S.; Sir William Crookes, F.R.S.; Sir David Gill, K.C.B., F.R.S.; Prof. Porter, of Montreal; Prof. Davis, of Harvard University; Dr. Backlund, director of the Imperial Observatory, Pulkowa, Russia; Prof. Bohr, Copenhagen; Prof. Engler, Berlin; Prof. Kapteyn, Groningen University; Prof. Penck, Vienna; and Dr. Sjögren, Stockholm.

At the conclusion of the ceremony, the Vice-Chancellor, Sir John Buchanan, read the following telegram from the Prince of Wales, Chancellor of the university:—"I desire to offer my hearty welcome to the members of the British Association who to-day receive our honorary degrees.—GEORGE, Chancellor."

The members of the association arrived at Durban on Tuesday, and were publicly welcomed in the City Hall, the Mayor of Durban, who was in the chair, expressing his confidence that the meetings would prove beneficial to mankind by widening the boundaries of scientific knowledge and by inculcating a deeper interest in scientific research.

In returning thanks on behalf of the association, Prof. Darwin is reported by Reuter to have said:—

It was exactly seventy years since His Majesty's ship *Beagle*, engaged in an historical expedition, sighted the coast somewhere about the latitude of Natal. At that time Durban was only a small village in the interior, entirely in the hands of the Zulus. It was a fact not hitherto recorded anywhere that his father, who was on board the *Beagle*, was anxious that Captain Fitzroy should put him ashore in order that he might make his way on foot or on horseback, or as best he could, to Cape Town. But it came on to blow, and the *Beagle* was unable to send a boat ashore. He felt that the chances which his father had of reaching Cape Town alive were so slight that he might say his presence on the platform that day was the result of a puff of wind.

The annual report of the council for the year 1904–5 was presented to the general committee at Cape Town on August 15. It is devoted chiefly to a statement of what action has been taken in connection with a resolution from the committee of the section of mathematics and physics expressing the opinion that the organisation of a Central Meteorological Department for the British Empire would be of the highest benefit to the progress of meteorological science and its application to the economic problems of the various colonies and dependencies. The resolution was referred to a committee consisting of Dr. A. Buchan, Dr. H. R. Mill, Dr. Shaw, and the general officers, to consider and report thereon to the council; and the memorandum drawn up by the committee and approved by the council on March 3 is abridged below:—

There is at present no provision for the systematic treatment of the meteorology of the British dominions. Observations of various kinds are made in nearly all the British colonies and dependencies, and summaries of these observations are generally included in the respective official publications. India, Ceylon, Canada, the several States of Australia, New Zealand, Mauritius, the Cape of Good Hope, and the Transvaal have organised meteorological establishments and issue regular meteorological publications. Information with regard to the meteorology of the Crown colonies and protectorates is to be found in the Blue-books of the several dominions.

There is no provision for the coordination of the methods of observing, the instruments employed, or the presentation of results. The want of a satisfactory system of coordinating the observations from the several dominions is to be deplored from two points of view—the economic and the scientific.

From the economic point of view, it is eminently desirable that facilities should be given for the comparison of the climatic features of the regions available for settlement and the conditions which affect various industries. At present it is possible to obtain a certain amount of information for an individual colony by reference to colonial Blue-books, but the data are of very different orders of completeness; and to ascertain in which colonies specified climatic conditions are to be found would be a labour of such difficulty as to be practically prohibitive. The Board of Trade publish a certain number of tables of meteorological results among their colonial statistics, but something of a more comprehensive character is required. From the scientific point of view the regular issue of the meteorological data for the British colonies in a published and easily accessible form is urgently desired by meteorologists of all countries.

But there is another aspect from which the scientific treatment of meteorological data must be regarded as having an important bearing upon the economic interests of remote parts of the Empire. Sir John Eliot, in his address to the British Association meeting at Cambridge, pointed out how the study of the meteorological conditions of the Indian Ocean and the bordering countries had been already applied to problems affecting the economic conditions of India as depending upon the variation of the monsoon rainfall, and he gave reasons for believing that the further prosecution of the inquiry promises valuable results for India, Australia, South and East Africa, and other countries bordering on the Indian Ocean if provision were made for dealing with the meteorological problem in a comprehensive manner with reference to the Indian Ocean as a whole.

Similar reasoning may be held to apply also to other oceanic areas, in or on the border of which British colonies are situated. In this connection it should, perhaps, be mentioned that the control of the meteorological organisation of the British West Indies is already passing into the hands of the United States. As a result of Sir John Eliot's representation, the attention of the council of the British Association has been directed to the advantages likely to accrue from the organised study of the meteorological problems affecting various groups of British dominions.

It has been further pointed out that such organised study can be most effectively secured by the establishment of a central institution devoted to these objects. Such an institution ought to be in close connection with the Meteorological Office, which is itself in regular correspondence with the meteorological organisations of foreign countries as well as those of the self-governing colonies. The meteorology of the ocean has been an essential part of the work of the office from its establishment in 1854, and oceanic data must necessarily be appealed to for the effective study of the meteorology of the neighbouring land areas.

By way of summary, the objects of the suggested institution may be briefly stated to be:—

(1) To give any information that may be required to the Governments or other authorities of the British dominions as to instruments and methods to be adopted for an effective system of meteorological observations.

(2) To compile and publish periodical reports upon the climatic conditions of the various parts of the Empire upon a comparable plan. To form an accessible depository of information upon matters concerning the climates of the whole Empire, and to afford information upon those subjects to inquirers.

(3) To provide a scientific staff for the study of the general meteorological conditions which affect the weather in the various British dominions, and in particular to promote the formulation of meteorological laws, and to apply them to explain and ultimately to anticipate the occurrences of abnormal seasons.

A copy of this memorandum was forwarded to the Colonial Office, with a covering letter suggesting that the question might be moved by a deputation to the Secretary of State. In reply, Mr. Lyttelton said that, whilst sympathising with the object which the council had in view, he did not think that there would be any advantage in receiving a deputation until he was in possession of further information on the subject. In satisfaction of this request, the committee drafted

another memorandum dealing mainly with the object numbered 3 in the foregoing summary, because the services indicated under numbers 1 and 2 would be included incidentally in the development of number 3. This memorandum is as follows:—

The idea underlying the proposal is to deal with the general meteorological conditions of wider areas than those with which the various meteorological offices of the world have hitherto been regarded as being primarily concerned. The British Meteorological Office does indeed concern itself with the meteorology of the oceans from the point of view of shipping. In effect, the proposal is to utilise further the information already obtained at sea in conjunction with land observations for the investigation of the meteorology of large ocean areas in relation to that of the adjacent land areas, and from the point of view of the land population.

It is known, for example, that the meteorological conditions of India, Australia, South Africa, East Africa, and Egypt stand in close relation to those of the Indian Ocean, and the study of these relations promises very important results in connection with the prediction of the seasons. This investigation requires that the information shall be treated in a manner different from that now followed for the more immediate purpose of its application to the interests of shipping.

The meteorological phenomena which are regarded as demanding careful study, in the first instance, are the following:—

The conditions of favourable and unfavourable seasons in India.

The droughts of Australia and South Africa.

The conditions of favourable and unfavourable Nile floods.

With those would be associated the relation of the weather of the Mediterranean to the Indian cold weather anomalies, and the relation of the South Indian anticyclone to the Antarctic ice.

The larger part of the necessary land data for the investigation of these particular questions can probably be found in the publications of the meteorological organisations of India, Australia, South and East Africa, Egypt, Mauritius, Hong Kong, Singapore, or can be furnished directly by those organisations. They should be supplemented by observations contributed by certain foreign Governments. The marine data would have to be compiled from the documents collected from ships by the meteorological departments of this country and India. The further development of the collection of observations—more especially of marine data—might be necessary, in order to complete the investigation.

The use of the data would be, in the first instance, to obtain a survey of the sequence of the more general weather changes over the whole region under consideration. The first step in the operations therefore would be to consider the nature and extent of the data available for the purposes in view, and the form in which they should be compiled for study or for publication.

A corresponding inquiry for the Atlantic Ocean and the countries bordering upon it is equally desirable, and should be conducted concurrently in the interests of the British Isles and the American and West Indian colonies.

In order to carry out the proposal, something more than what would be generally understood by "a moderate addition to the staff of the Meteorological Office" is required. The proposal involves a scientific investigation of a very important character which could not be regarded as merely an incidental addition to the usual operations of the office. A man of suitable scientific attainments should be responsible for conducting it in consultation with, and under the general supervision of, the director of the Meteorological Office. It is desirable to mark the nature of the qualifications expected in the person to whom the work is entrusted by giving him the title of assistant director, and providing a salary of from 400*l.* to 600*l.* a year. It should be remembered also that the Meteorological Office could not find accommodation for the proposed additional staff without some addition to the space at present available.

It is estimated that the annual cost of the work would be 2000*l.*, rising in five years to 2500*l.*, made up as follows:—

	£		£
Salaries: Assistant Director	450	to	550
Scientific assistant, computers and clerical staff	1,050	to	1,300
Publications, printing and stationery ...	300	to	500
Incidental Expenses, office rent, &c. ...	200	to	150

The estimate is based on the supposition that the Meteorological Committee would be willing to undertake the general control of the department as a branch of the Meteorological Office.

It may be mentioned that the Government grant to the Meteorological Office at present stands at 15,300*l.* The cost of the marine department, as shown in the report of the Meteorological Council for 1903–4, is 1366*l.*, exclusive of office expenses, publications, &c.

The council, in approving this memorandum, has caused it to be conveyed under a covering letter to the Secretary of State for the Colonies.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY PROF. H. A. MIERS, M.A., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

IN opening the proceedings of Section C in its first visit to South Africa, and speaking first on behalf of those who are visitors, I think I may justly claim that to no Section of the British Association can this visit be more interesting or even more exciting than to us; we enter for the first time a country the geological features and history of which, and the mineral productions of which, have long aroused the keenest interest among European geologists and mineralogists.

We have followed the discoveries and discussions of South African writers; we have read your views and have become familiar with your terminology; we have heard the reports of those who have visited the country, either as travellers or with the special object of investigating its geological problems or mineral resources; and, indeed, ever since the Geological Society of London received the historic papers of Andrew Geddes Bain, the father of South African geology, many of the memoirs of your own geologists have been communicated to European societies and journals; we have looked from afar with yearning eyes upon this alluring country; and at length we have found ourselves upon its shores.

It has not been given to many of us to see those great pioneers of South African geology whose work was done in the days before amateurs and experts could come out for a few weeks or months to take a hurried survey of the country; but their enduring labours, which have laid the foundation of all subsequent work, are well known to us, and it is not necessary for me to do more than mention the familiar names of Bain, Wyley, Stow, Atherstone, Sutherland, and Dunn. Of these only the last named survives; but when one remembers that his maps of North Cape Colony and of Orange River Colony have served as the basis of the maps now in use, one is reminded how recent is the whole history of South African geology, and how much was achieved in so short a time by these early workers.

It is exactly one hundred years since John Barrow wrote the concluding words of his "Travels in South Africa" which first directed attention to the geology of this country; it is only fifty years since Bain sent home the manuscript of the classic papers to which I have already alluded.

Since their days many have been the scientific visitors to the country who have remained here for longer or shorter periods, whose works have made us familiar with its problems and have contributed to their solution; the names of Cohen, Draper, Exton, Gibson, Green, Griesbach, Passarge, Rubidge, Sawyer, Schenck, and Seeley recall some of the most substantial scientific work which has been done either by visitors or residents. Several others who, without visiting the country, have by their researches in Europe helped to unravel the problem of South African stratigraphy were enumerated by Dr.

Corstorphine in his interesting and exhaustive Presidential Address last year.

If we must regret that we never had the opportunity of seeing the great pioneers and the earlier workers, we may rejoice that we have been able to meet those who are now actively engaged in continuing their labours; the period of cursory visits and fragmentary essays is closing and the era of deliberate and systematic surveys is beginning; we now look for authoritative information to the Cape Survey inaugurated by Dr. Corstorphine in 1895 and so ably continued by his successor Mr. Rogers; to the Transvaal Survey begun by Dr. Molengraaff in 1897 and auspiciously revived under Mr. Kynaston; and to the Natal Survey which Mr. Anderson has so successfully directed since 1901. I hope that it will not be long before there is no part of South Africa outside the direct supervision of a systematic and well-ordered survey.

There is perhaps some danger lest in a developing country, where the commercial possibilities are prominently before all eyes, the immense importance of such surveys should be overlooked, and lest it should be thought that what appears to be purely scientific research may be left to take care of itself until the mineral wealth of the country has been explored. I cannot enter too emphatic a protest against such a view; how closely the two interests are knit together must be apparent to anyone who reflects that the nature and sequence of the more northerly formations which have yielded coal, diamonds, gold, and metalliferous deposits can only be studied in the light of the more intelligible geology of Cape Colony and Natal. It is, moreover, immensely to the advantage of South Africa that you have intimately connected with the mining industry geologists of such training as Doctors Corstorphine, Molengraaff, and Hatch, who have all gained valuable experience upon geological surveys.

I may now, perhaps, cease to speak merely as a representative of the visitors and identify myself more closely with the Section as a whole; for the most gratifying feature of this meeting is that it is not merely a visit of strangers who are enjoying your hospitality, but that with Section C of the British Association is fused Section B of the South African Association, so that for the time being we are all colleagues; and even such vexed questions as the correlation of the rocks of the Transvaal or of Rhodesia with those of the Cape, or the origin of Banket, or of Blue Ground, or the extension of the Main Reef Series (perhaps it is no longer necessary to include the problem of the Dwyka conglomerate) can be discussed by us on the spot as members of the same body inspired by the same earnest desire for truth.

I began these preliminary remarks by asking that I might be regarded as the spokesman of the visitors, and therefore represented myself as a geologist visiting the country for the first time. I must, however, make a frank confession. Not only is this my second visit to the country, but I have not even any claim to be called a geologist. My training and experience have been such that upon many of the questions which must be most interesting to this Section I am not competent to form an opinion or to appreciate properly the evidence. I must, therefore, crave your indulgence if in this Address I refrain from discussing any of the problems of surpassing interest which naturally engage the attention of those who are occupied with the study of South African geology. It would indeed be an impertinence for me to do so.

I venture, however, to hope that the frontier between geology and mineralogy is so ill-defined—if indeed a scientific frontier can be said to exist—that the thoughts and occupations of one who has confined himself to the study of minerals, and that rather in the laboratory than in the field, are not alien to the interests of Section C.

Experimental Geology.

A somewhat lamentable aspect of modern science is the vast array of unorganised facts which are awaiting coordination; this is too often because they have been amassed without any definite idea of the purpose which they may serve; consequently it may happen that laborious observations belonging to one science may fail to attract the regard of a neighbouring science merely for want of the mutual acquaintance which would make them serviceable to each other; and in these days of exclusive specialisation the introduction which might lead to a happy union is, perhaps, not brought about for years. None can be more fully alive to the importance of such an alliance than those whose work lies on the borderland between different sciences; the mineralogist, for example, is in contact on the one side with the experimental sciences of chemistry and physics, and on the other with geology, which has scarcely yet entered the experimental stage. He cannot fail to be impressed by the need of the appeal to experiment on the geological side of the border, and it is perhaps his duty to supply the want so far as lies in his power.

Owing to this very need some of the most difficult problems in geology are those concerned with the origin of minerals and of the rocks which they compose. One need but recall the many theories which have been held about the origin of mineral deposits, the filling of metalliferous veins, the local concentration of certain minerals, the distribution of various rock types, the existence of rock magmas of diverse compositions, and the differentiation of their constituents. Could the importance and difficulty of such problems be better illustrated than in South Africa, and by its two most valuable minerals, gold and diamond?

Now all these are problems in which direct appeal may, and indeed must, be made to laboratory experiments; the well-defined minerals of which the earth's crust consists do not, after all, number much more than 800, and of these many have already been manufactured in the laboratory. Speculation upon the origin of rocks and minerals should surely be controlled by the results of experiments, and equally should experiment which is to be of service to geology be guided by a knowledge of the problems to which it is to be applied. It will be my object in the present Address to illustrate these principles by examples drawn from recent experimental work which can be applied to geological problems, and to indicate the course which such research is likely to pursue in the immediate future.

It seems to be sometimes expected of a Presidential Address that it should contain a summary of the progress of a science during past years, and this is no doubt very useful and instructive; but if we are to go forward in our scientific work we must not be satisfied with the patient accumulation of details, or content to congratulate ourselves upon the number of them which have been amassed. I venture to think that it is more profitable to take our stand upon the actual work of to-day, and from that tower of observation to look forward to the future rather than backwards to the past; to exclaim with the poet—

> "No, at noonday in the bustle of man's work-time
> Greet the unseen with a cheer!
> Bid him forward."

It would be interesting enough to trace the history of the artificial reproduction of minerals, beginning with the famous experiment of James Hall; to follow the lines that led to the development of the French School during the last half of the nineteenth century; to dwell on the researches of Senarmont, Ebelmen, Daubrée, and Sainte-Claire Deville; to show how the increasing study of petrography and the invention of the electric furnace have led to renewed activity in the attempts to reproduce igneous rocks and the rock-forming minerals; to discuss the more modern experiments of Fouqué and Lévy, Lagorio, Loevinson-Lessing, and Morozewicz; or to describe the manufacture of many an interesting mineral by de Schulten and others who are actively prosecuting research of this nature, including such sensational achievements as the production of the ruby by Frémy and of the diamond by Moissan.

Instead, however, of attempting a survey of all that has been done, or even of all that is being done in the artificial reproduction of minerals, let me adhere to the principle that I have laid down, and discuss only a few of those researches, now being carried on, which promise to be most fruitful because their methods and aims are inspired by the discoveries and views of modern chemistry and modern physics.

Van 't Hoff's Work on the Salt Deposits.

Among such researches the most remarkable are those conducted by Prof. van 't Hoff and his pupils during the last eight years upon the Stassfurt salt deposits. These

deposits are of enormous extent, more than 1000 feet thick, and consist of fairly well-defined layers of various sulphates and chlorides of sodium, magnesium, and potassium, and their double salts and hydrates. It has long been supposed that the minerals have been derived from the evaporation of sea-water which contains in solution the chlorides of sodium, magnesium, and potassium, with sulphate of magnesium and small quantities of calcium salts; and the general sequence of the minerals is that of their solubility; the less soluble sodium chloride crystallised out first and is at the bottom, while the very soluble magnesium chlorides, having been the last to crystallise, occupy the top of the series. But the problem is by no means so simple as to be one of mere solubility in water; the rock salt itself persists through the whole series, and some of the associations are difficult to explain.

As is well known, the modern theories of solution mainly rest upon the behaviour of dilute solutions from which the principles of electrolytic dissociation have been deduced; but in the case of the concentrated solutions from which dissolved substances actually crystallise, very little is really known about the liquid itself. A great deal is known, however, about its equilibrium with the solids that separate from it, and the general laws of this equilibrium are expressed by the phase-rule deduced from mathematical considerations by Willard Gibbs, which states how many mechanically separable constituents can coexist under varying conditions of equilibrium in a system containing a definite number of chemical components.

A solution saturated with a given substance is one which is in equilibrium with that substance when the latter is in contact with it in the solid form; the phase-rule indicates the number of solids which must be in contact with a given solution; the only difficulty in practice is to determine the nature of the double salts or distinct hydrates that may be formed.

By means of a series of experiments upon the solubilities of these salts, either singly or in the presence of one another, in order to determine the composition of solutions saturated simultaneously with two or more substances, it is possible to obtain a graphic representation of all possible solutions containing the salts present in sea-water. From this the course of crystallisation of any particular solution, for example sea-water, can be predicted.

The general sequence thus theoretically predicted is as follows:—(1) Rock salt; (2) Rock salt with the magnesium sulphate, epsomite; (3) Rock salt with the double sulphate of potassium and magnesium, leonite; (4) Rock salt with leonite and the potassium chloride, kainite; (5) Rock salt, the magnesium sulphate kieserite, and the double chloride of potassium and magnesium, carnallite; (6) Rock salt, kieserite, carnallite, and the magnesium chloride, bischoffite. This last combination will persist until all the water is evaporated. This is found to be the general sequence, not only of the salts obtained on evaporating sea-water at 25°, but also of the Stassfurt deposits.

Up to this point the results have been summarised by Dr. E. F. Armstrong in a report presented to the British Association in 1901. Since that date the research has been prosecuted actively by van 't Hoff and his pupils, and now the conditions of equilibrium at 25° have been mapped out, not only for the above compounds, but also for the minerals thenardite, glaserite, astrakanite, and reichardtite, which occur in these deposits. The whole process of crystallisation of the solution, from which no fewer than twelve different salts have separated, can, therefore, be predicted, and their sequence and associations can be traced through numerous stages, beginning with the separation of rock salt and ending with a mixture of rock salt, kieserite, carnallite, and bischoffite.

In reconstructing the history of these deposits account must also be taken of the varying vapour pressures of the solutions which are saturated with the different compounds, as this really determines which particular compounds are stable, so that the matter is by no means so simple as might appear from this brief sketch. It is further necessary, in order to bring the process within reach of calculation, to assume that each deposit is removed from contact with the mother liquor after it has crystallised out; but fortunately this is practically what has happened in the Stassfurt deposits, for each layer is more or less separated from the succeeding one by an intervening layer of clayey material.

It may be possible even to go a stage further and obtain a clue to the actual temperatures that prevailed, for two minerals, langbeinite and löweite, are absent from the theoretical model made by van 't Hoff to represent what must happen during evaporation at 25°; and this indicates that while the deposits crystallised the temperature really rose higher than 25°, probably as high as 43°; in fact, after the conditions of equilibrium have been worked out, the appearance or disappearance of certain minerals can be used as a sort of geological thermometer, capable of indicating the limits within which the temperature can have varied.

The whole investigation is a splendid example of experimental research devoted to a particular problem and directed by a well-established theory; the chemist in his laboratory has now succeeded in tracing the changes that took place ages ago in the bed of a land-locked sea as it laid down its contents and finally became a dry basin, although he is not able to reproduce the original conditions or to work for the long periods which Nature had at her disposal. Without the logical consideration of the conditions necessary for equilibrium, countless experiments might be made upon these salts, and an immense amount of speculation might have been devoted to their possible reactions in the liquid state, about which we know so little, instead of to their equilibrium when solidifying, about which we know so much more.

Some Petrographical Problems.

The other geological problems which I have mentioned have also been beyond the reach of actual experiment, for it is hopeless to attain the immense pressures and high temperatures or the enormous time that may have been required for the growth of natural minerals in rocks and veins; and so when difficulties are encountered there is a tendency to "explain" them (if the word may be so misused) by reference to the mysterious effect of conditions which cannot be brought directly within the reach of experiment.

I cannot help thinking that this has to some extent occurred in the discussion of the petrographical problems which I propose to consider next. There are two great liquid reservoirs from which minerals have crystallised—the sea, with its dissolved salts, and the subterranean baths of molten silicates, from which the igneous rocks have been derived. It is true that in the sea two of the constituents, water and sodium chloride, largely predominated over the others; but, after all, both sea and lava are liquids subject to the same physical and chemical laws.

An admirable summary of the evolution of petrographical ideas was given in the Presidential Address to the Geological Society of London in 1901 by Dr. Teall, who dealt both with the consolidation of rocks from molten magmas and their differentiation into species. It is not, therefore, necessary for me to consider anything but recent work which has been done during the last four years, and the earlier controversies may be left out of account.

Among the many problems relating to the mineral and chemical constitution of rocks which have yet to be solved, two, and those perhaps the most important, should lend themselves most readily to experimental treatment. The first is the problem of rock differentiation: why does a magma, even one which has presumably crystallised *in situ*, separate itself into zones, or layers, or streaks of different constitution? And the second is the problem of mineral differentiation: why does a granite magma, for example, crystallise as a mixture of the particular minerals mica, felspar, and quartz, and why is the least fusible mineral the last to crystallise?

It will scarcely be possible for me to deal in this Address with more than the second of the two problems, but it will be apparent from the somewhat parallel case of the salt deposits that the mere order and manner of crystallisation of a mass of molten silicates must be a sufficiently complex problem to exhaust our attention for the present.

Magmatic Differentiation.

If we are to consider only recent experiments which have a bearing upon the problems of rock magmas, it is not necessary to say much about the first great petro-

graphical problem, that of the differentiation of magmas into various rock types; for in this connection very few experiments have been made, and practically none of recent date. Observations of the facts as they present themselves in the field accumulate every day; almost every important petrographical region is being studied with the particular object of determining the mutual relations of its rock masses and the factors which have contributed to their differentiation. They have been ably discussed by Becke, Brögger, Becker, Cole, Harker, Iddings, Judd, Lacroix, Lévy, Pirsson, Rosenbusch, Teall, Washington, Zirkel, and many others; appeal has been made to the action of gravity, of temperature differences, of diffusion, of electric currents, of fractional crystallisation, of re-fusion, of chemically combined water, of absorption of the country rock; but with the exception of a single case, observed in the glassworks of Targowek, in which the top of a molten glass was found to contain less lime and more silica than the bottom, and some observations by Doelter upon boron-glass, there is scarcely a single experiment upon silicates which really bears directly on the question. That artificial glasses are far from homogeneous is known to glass-workers and to makers of lenses, but there is nothing comparable with the splitting of a magma into two or three distinct liquids which solidify as different rocks.

It is in the case of laccolites that the problem ought to present itself in the simplest form, for we may regard them as basins of igneous rock which have been practically imprisoned within solid walls and have crystallised *in situ*. There can, I think, be no doubt that differentiation has generally taken place even in such basins, that the margins have often a different mineralogical and chemical constitution from the more central portion, and that the differences are greater than can be accounted for by solution of the enclosing rock, and are often of a chemical nature which cannot be so explained.

The various theories that have been propounded fall into two distinct classes—those which seek the cause in the separation of solid material from the liquid, so that when the latter subsequently crystallised it constituted a different rock from the former; and those theories which assume that different liquids have separated from each other and then solidified as different rocks.

The first conception satisfactorily explains the manner in which the least soluble minerals are concentrated at the bottom or margin of an igneous mass, for they naturally crystallise first where the mass is coolest, or where contact with other crystals may have occurred; or even if they have been precipitated as a cloud throughout the magma they must be carried about by convection currents and ultimately sink together unless the magma be very viscous. Most geologists will probably agree with the conclusions of Vogt that some of the most important deposits of metals, metallic oxides, and sulphides have been produced by magmatic differentiation from deep-seated magmas which now constitute basic rocks associated with them. But this does not explain how the mass which has crystallised out may be not a mineral but a rock.

The actual observations on crystallising solutions do not amount to much; it is quite clear from laboratory experiments that crystals do grow by means of convection currents, which produce a flow of stronger solution towards the crystal and of weaker and warmer solution upwards and away from the crystal. The concentration currents can easily be seen in any ordinary aqueous solution as streaks in the liquid. Again, that there might be a slight difference in the concentration of the upper and lower, or of the warmer and cooler parts of a solution has also been shown. That a very considerable difference in concentration can be produced by centrifugal action was proved only last year by the experiments of Calcar and de Bruyn, in which solutions contained in rapidly rotating vessels became more concentrated in the portions furthest from the axis of rotation.

Schweig has recently suggested that the crystals which fall to the bottom of a rock-magma may be unstable compounds, which re-dissolve when the pressure is relieved, and so give rise to an underlying magma of different chemical constitution.

Harker, also, some time ago, suggested the existence of horizontal layers of different liquid magmas above each other, thus attempting to explain the presence of quartz in basic rocks as due to the crystals which had sunk into the basic magma from a more acid magma floating upon it.

The second theory, that of liquid differentiation, regards such layers as actually produced by the spontaneous division of a magma into two liquids of different composition, and if it be tenable seems more capable of explaining the geological facts.

The experiments bearing on the subject are well known, and have been quoted by Bäckstrom and Teall; mixtures of phenol and water, or of aniline and water, which form a homogeneous solution above a certain temperature, may below that temperature (which is a sort of critical point of the solution) divide into two solutions, one consisting of phenol in excess of water, the other of water in excess of phenol; and these two solutions are not miscible, but separate into two distinct layers.

Many pairs of substances have now been found to exhibit this incomplete miscibility, which varies with the temperature and may at certain temperatures become complete; among them are some of the metals such as zinc, lead, bismuth, and silver.

If rock-magmas can really behave in this way, there is no difficulty in explaining their differentiation; but experiments upon fused silicates have not disclosed anything of the sort, though they are made far below the critical temperature.

The case of nicotine and water, which has recently been described by Hudson, is remarkable and suggestive: above a temperature of 205° a mixture in equal proportions is a clear liquid; at 205° it divides into a saturated solution of nicotine in water floating on a saturated solution of water in nicotine; at 90° these two layers change places; at 64° they mix again and the liquid becomes once more homogeneous.

It is, of course, possible that fused silicates at experimental temperatures correspond to nicotine and water below 64°, and that rock-magmas correspond to the same mixture at higher temperatures.

In discussing the reasons why in laccolites of the Square Butte type the margin should be more basic, and in laccolites of the Magnet Cove type more acid than the centre, Washington regards the magma as a mutual solution of an alumo-alkaline substance with a ferro-magnesian substance; whichever of these is in excess may be regarded as solvent, and crystallises first, for example, either the syenite or the shonkinite. In a laccolite where no differentiation has taken place, as in the Henry Mountains type, he supposes the mixture to be eutectic or such that they crystallise together. Pirsson, in a paper recently published upon the "Highwood Mountain Laccolites of Montana," while attributing a greater part in the process to the action of convection currents, also regards the ferro-magnesian minerals, taken together, as constituting the solvent and crystallising first as shonkinite.

In fact, stated quite baldly, these latest views tend to a compromise between the two theories which I have just mentioned. They regard the splitting of the magma as produced by a fractional crystallisation, only now the mass which crystallises is not a mineral but a rock; in other words, they assume that rocks may be dissolved in each other, and may crystallise from each other as though they were minerals.

In this matter of magmatic differentiation, then, there has been during the last few years a large accumulation of geological evidence, a little new speculation, but practically no new experimental work, and scarcely any progress.

Mineral Differentiation and Eutectics.

Let us pass to the second petrographical problem, that of mineral differentiation, the nature and order of the minerals which crystallise when a cooling magma becomes a solid rock mass.

It has been laid down by Rosenbusch, and is accepted as a general rule (in spite of many exceptions), that the order in which the various minerals crystallise is one of increasing acidity, ores and oxides and so-called accessory minerals first, then those minerals which are comparatively poor in silica, then those which are richer, and finally, if

it be present in excess. the silica itself. It has also been supposed that the order may be one of the fusibility of the various minerals under the conditions of their formation; the least fusible minerals being the earliest to crystallise, and the most fusible the latest. Interesting speculations concerning the melting point of quartz at high pressures, and its consequent order of crystallisation, have, for example, been published recently by Stromeyer and Cunningham.

It is not necessary, however, to regard the molten magma as a mere mixture of fused minerals which solidify more or less independently and consecutively; it is more reasonable to regard the whole magma as a solution in which the various minerals are dissolved, and from which they crystallise as it cools. Now the temperature at which a substance separates from solution is generally far below its melting point, and the order in which the constituents of a mixed solution will crystallise is the order of their solubility in it, and bears no direct relation to their fusibility or to their chemical composition.

Teall in 1901, after discussing the controversies and the evidence on which they are based, came to the conclusion that rock-magmas are solutions, and that the order in which the minerals consolidate depends upon the nature of the constituents and their properties, and is not by any means the order of their freezing points. As to the particular minerals which crystallise, he thought that the molecular grouping in the magma is determined by mass action and by the mutual affinities of the bases, the silica, and the alumina. Concerning future research he ventured to predict that the next advances were to be made by experiment controlled by the modern theory of solutions.

Thirteen years earlier Teall had himself contributed a valuable suggestion based upon Guthrie's work on cryohydrates. When a mixture of nitrate of lead and nitre is fused and allowed to cool, the constituent which is in excess will crystallise out as from a solvent until the proportions left in the liquid state are 47 of lead-nitrate to 53 of nitre, and this mixture will then solidify at 207°, not as a uniform compound, but as an intimate mixture of the two salts, the *eutectic,* which crystallises at the lowest possible temperature, and is the only mixture which has exactly the same composition as the liquid from which it solidifies. Teall made the illuminating suggestion that micropegmatite is an eutectic consisting of quartz and felspar, and represents in certain rocks the final mother-liquor from which the other minerals have crystallised out. Eutectics in metallic alloys have been much studied during recent years: in the Address of 1901 Teall was able to strengthen his case by showing that spherulitic and micropegmatitic structures found in obsidian and other acid rocks are paralleled by similar structures developed in eutectic alloys, according as they have been rapidly or slowly cooled.

In the following year appeared a theoretical paper by Meyerhoffer concerning the ideal case of a molten mixture of two substances, *a* and *b*, which do not suffer double decomposition, nor form a double salt, nor an isomorphous mixture.

Let a diagram be constructed, with temperatures as ordinates and composition of the magma as abscissæ, giving by a curve the nature of the magma which is in equilibrium with either solid *a* or solid *b*. The curve has the form of a V; one arm represents the temperature and constitution of the liquid which can be in equilibrium with *a*, and the other that of the liquid which can be in equilibrium with *b*; and the lowest point corresponds to the eutectic, which is in contact with both.

Let a point above the curve represent the temperature and constitution of the liquid magma containing excess of *b*; as the magma cools this point descends to the *b* branch and travels along it while *b* is crystallising out, until the eutectic point is reached, when *a* and *b* both crystallise out together at a temperature below the melting point of either. The order of crystallisation is therefore determined solely by the composition of the magna as compared with that of the eutectic. If, however, the liquid be cooled slowly, crystallisation may be postponed until it has become supersaturated with regard to one constituent or the other, or both; a state of affairs represented by a prolongation of the arms of the V below its lowest point, and then the order of the crystallisation may be inverted.

In a rock-magma there are of course many other factors to be taken into account as determining the order in which the minerals separate; for example, the formation of both double salts and isomorphous mixtures, the possible production of unstable solid compounds which may become converted into stable compounds or may be re-dissolved soon after they have come into existence; and also the relative velocities of crystallisation, changes of temperature and pressure, action of steam, &c.; but the principle laid down by Meyerhoffer must be that which controls the process.

It might be objected that on this hypothesis the consolidation of every rock-mass ought to terminate with an eutectic mixture, whereas this appears to be by no means the case; in fact, it is only among some acid rocks that structures much resembling the eutectic mixtures of alloys are to be found. On the other hand, if the conditions of cooling are such that the magma becomes supersaturated with one mineral after another, it will overshoot the eutectic composition before each crystallises, and the final consolidation may be a well-marked sequence instead of a simultaneous crystallisation.

The controversies which have raged concerning the classification of rocks and their nomenclature appear to me to contribute little to the real advancement of knowledge. There are, I think, two more profitable lines of research which should accompany each other. We may take the facts as we find them and endeavour to explain them by the known laws of solutions aided by the phase-rule, provided that we have good reason to believe that rock-magmas behave like solutions, and we may make experiments upon slags and fused silicates and ascertain how far they resemble natural rocks in their behaviour and their mineral constitution. Some of the workers in this field have been led to regard rock-magmas as undoubtedly similar to ordinary solutions; others hesitate to seek an explanation for their features in the laws which govern the solutions studied in the laboratory. The two views are represented in the persons of the two men whose names are most closely identified with recent experiments, Vogt of Christiania and Doelter of Graz.

Doelter's Work on Melting Points and Solubilities.

The labours of Doelter and his pupils have been largely devoted to the melting points of the rock-forming minerals and their solubility in silicate magmas. From experiments upon these minerals and their mixtures they have come to the conclusion that in many cases the melting point of the mixture is about the mean of the melting points of the constituents, and that in such cases, therefore, there is no evidence that the freezing point is lowered, or that an eutectic mixture is formed; so that it is not safe to apply the theory of cryo-hydrates to fused mixtures of silicates.

Doelter is therefore led to regard the silicate-magmas rather as mixtures of various constituents which may be dissolved in each other, but which are not by any means necessarily identical with the minerals which separate on cooling. The whole process seems to him to be far too complicated to be explained by any such simple principle as the mere relative proportions of the various constituents to each other and to their eutectic mixture; the order of crystallisation must be determined by a number of factors, such as temperature, velocity of crystallisation, the interval between the softening and fusing of each mineral (which he finds to be considerable), viscosity, capillarity, the presence of water and mineralising agents, and the absorption of adjacent rocks.

To choose a simple example: minerals such as zircon, corundum, and titanite separate for the most part early, because they are less soluble. On the other hand, magnetite is one of the more soluble minerals, and yet it is one of the first to separate; the same is to a certain extent true of augite, but not always. It is possible that in a magma which still contains the iron of the magnetite in solution plagioclase and augite may be comparatively soluble and magnetite comparatively insoluble, but that when magnetite has already crystallised out from the magma the plagioclase and augite may be comparatively

insoluble; the experiments which are wanted are experiments upon the solubility of certain minerals in magmas of known composition under known conditions; in these and similar instances the order of separation is that of the solubility, but such physical factors as the velocity of crystallisation (which varies very considerably with the temperature), and the viscosity, may completely invert the order.

Direct experiments made by Barus and Iddings upon the electric conductivity of silicate magmas afford evidence that such magmas contain dissociated as well as undissociated molecules, so that they cannot be regarded as merely fused mixtures of certain minerals. If two or more rock-forming minerals be fused together it may happen that they form new compounds and crystallise out as different minerals, or if one or the other remains unchanged it may crystallise out in a different proportion. All this shows that double decomposition goes on in the liquid. We cannot therefore expect, without knowing the degree of dissociation, to make much use of the lowering of the freezing point in order to calculate the other factors in the process of rock-formation.

Doelter concludes that upon the whole the normal order of crystallisation in rocks is in the main that laid down by Rosenbusch long ago, namely, an order of increasing acidity, but that it is determined by the mutual affinities of the molecules in the magma, and by the relative power of crystallisation of the components into which they unite themselves, and that the physical factors which I have already enumerated play a very important part in the process. No one has endeavoured more systematically than Doelter to determine for the rock-forming minerals the melting points and the solubilities, without which it is impossible to make much progress in our reconstruction of the history of rocks. He has recently shown us how the microscope may be used in the study of fused silicates at high temperatures, and has so opened up a new field of research.

Vogt's Applications of the Laws of Solutions.

The work of Vogt has extended over many years, and is now summarised in two remarkable memoirs recently published by him, in which are expressed his mature opinions upon silicate magmas; the reasoning is based upon his own experiments, upon those of Doelter, and upon the classic researches of Ebelmen. It is now generally conceded that the particular minerals produced in a silicate magma depend much more upon the chemical composition of the magma than upon temperature and pressure; Lagorio and Morozewicz were led to this conclusion by their own experiments upon fused silicates. Experiments upon slags at ordinary temperatures and pressures may, therefore, be invoked to elucidate the formation of rocks.

In 1902 Vogt stated his conviction that the laws of solutions may be applied to igneous rocks, and his two recent memoirs are, in fact, an attempt to explain the experiments upon slags and fused silicates as examples of the operation of these laws.

All important, according to him, is the composition of the eutectic mixture; he finds that if the analyses of silicate magmas be arranged according to their oxygen ratio or acidity, the various minerals of which they consist make their appearance within fairly well-defined limits. For example, in the case of the Ca-Mg-Fe-Mn slags, which contain little alumina, olivine and the melilite minerals only make their appearance in the more basic slags, and the metasilicates in the more acid, the limit between the two corresponding to an acidity of about 1·6.

The limit of individualisation between the various minerals is supposed to correspond to their eutectic mixture. Such slags may, therefore, be regarded as a mutual solution of two or more of the minerals olivine, enstatite, hypersthene, augite, the gehlenite-melilite group, akermanite, wollastonite, and the hexagonal metasilicate, which is so characteristic of the more acid slags. The particular minerals which make their appearance are practically determined by the acidity of the magma and by the relative proportion of the bases present, particularly by the ratio of the calcium to the magnesium-iron-manganese group; in other words, Vogt asserts that a silicate magma is a mutual solution of the various crystalline compounds that actually make their appearance as it solidifies, and that the order of crystallisation depends upon their proportion in the magma as compared with their proportion in the eutectic. The old conception of a solvent and a solute ceases to have much meaning; the matter which is of supreme importance is the nature of the eutectic mixture when the constituents are given; thus micropegmatite and microfelsite represent the eutectic of felspar and quartz, and correspond to a mixture of about 74 parts of felspar to 26 of quartz, as indeed has been stated by Teall.

Now, if we are justified in regarding rock-magmas and fused silicates as mutual solutions of certain definite compounds, and if these compounds are actual minerals or other silicates which crystallise out of the magma when it cools, we are also justified in making use of the properties of these minerals when we apply to the magma the known physico-chemical laws which govern solutions.

The number and nature of the minerals which can be in equilibrium with each other and the solution are to be determined by experiments upon their solubility interpreted by the phase-rule of Willard Gibbs, and especially by the laws which Roozeboom and other physical chemists have deduced for components which form double salts or isomorphous mixtures. Knowing the components we ought, therefore, to be able to determine their latent heat of fusion, their specific heat, the lowering of the freezing point of their mixtures, and from these data to calculate the true formulæ of the rock-forming minerals. It will readily be understood that in a mixture of quartz and orthoclase, the lowering of the freezing point below that of either of the constituents, as calculated by van 't Hoff's formula, from their melting points, latent heats, and molecular weights, will be very different according as the formula of quartz is taken to be SiO_2 or Si_3O_6.

Vogt boldly attacks the whole problem as one that can be solved on these lines; we have good reason to believe that the slags and rock-magmas are solutions; we know their constituents; we can therefore proceed to experiment with these constituents and to predict the behaviour of their mixture according to the principles of physical chemistry. The order of crystallisation is mainly determined by the relative composition of the magma and the eutectic, and the composition of the eutectic may be calculated from the intersection of the freezing-curves.

One interesting result is the conclusion that in the silicate magmas which have been the subject of experiment the minerals produced are all of very simple constitution; that, for example, olivine, diopside, akermanite, melilite, and anorthite have the simplest possible formulæ corresponding to their analyses and are not polymerised. Mineralogists will welcome this conclusion if it be true, for it has occasionally been the fashion on theoretical grounds to attribute a high degree of polymerisation to many minerals, and nothing is easier than to account for many difficulties if one may multiply the formula of a mineral by any number that is required. It should be added, however, that Doelter, calculating from his own experiments, is led to think that some of the minerals must have formulæ which are multiples of their empirical formulæ.

Vogt even goes a step further in his application of the principles of modern chemistry. The order of crystallisation appears to be by no means always that of the solubility, but indicates that a mineral is sometimes not so soluble as might be supposed. Now another principle in the modern physics of solutions is that by adding to a solution of one substance a new electrolyte containing an ion common to both the solubility of the first is diminished, and Vogt does not hesitate to apply this principle.

Thus spinel and felspar in mutual solution, when felspar is in large excess, should on cooling yield felspar first. But in many basic rocks spinel is the first to crystallise; this is, according to Vogt, due to the presence of ferromagnesian silicates containing the Mg-ion which is also present in spinel; if these be partially dissociated the solubility of the aluminate will be lowered.

An obvious criticism on this argument is that if the dissociation is so slight that it may be ignored for one purpose, it is hardly fair to invoke its powerful action for another, and it is possible that Vogt in his enthusiasm for a theory attempts to explain too much by its aid.

It is clear, however, that the labours of Vogt have been precisely in the direction indicated by Teall in the words that I have quoted, "experiment controlled by the modern theory of solution"; and if his opponents are tempted to think that he may have carried the principle too far with insufficient data, they cannot but admire the brilliancy, the persistency, and the ingenuity with which he has applied the newer theories of solution at every turn.

Heycock and Neville's Work on Alloys.

I must next refer briefly to another remarkable series of researches which have recently been published.

The laws which govern the solutions of metals in metals, that is to say alloys, appear to be the same as those which prevail in the case of other solutions; it is in alloys that the nature of eutectic mixtures has been most fully studied; and the phase-rule and Roozeboom's deductions from it have been applied with signal success to their investigation. A new impulse has been given to the subject by the work of Heycock and Neville which is summarised in their Bakerian lecture delivered last year upon the copper-tin series of alloys. They have studied the changes which occur during the cooling of an alloy by taking small ingots of the cooling metal and chilling them at certain temperatures; this arrests the gradual process of cooling and causes all that is liquid at the moment of chilling to become suddenly solid; it is then possible by polishing and etching the ingot to show the solid crystals set in the congealed ground-mass and to study their nature. They have been able to interpret their results by means of Roozeboom's remarkable work on the solidification of mixed crystals published in 1899. For our present purpose it is sufficient to consider these results as applied only to alloys. If a diagram be constructed with the temperatures for ordinates and constitution for abscissæ, Roozeboom has shown that two curves may be drawn. The first is the freezing-point curve, or *liquidus*, giving the temperatures at which an alloy of any composition begins to solidify: this is a broken curve and each section of it represents the temperature of equilibrium between the liquid and a different solid alloy; the breaks represent the temperatures and constitution of the liquid at which one solid ceases to be produced and another begins. The curve is, of course, far more complicated than the simple V of Meyerhoffer, since that represents the cooling of a mixture the constituents of which do not form compounds or isomorphous mixtures, whereas the alloys do both. In this respect the alloys resemble a silicate magma which is crystallising as a rock-mass: indeed it will be remembered that Mendeléeff insists upon the general similarity of silicon compounds to metallic alloys.

The second curve of Roozeboom is the melting-point curve, or *solidus*, representing the temperatures at which an alloy of given composition becomes completely solid. Points above the liquidus represent the condition of alloys which are completely liquid; points below the solidus that of alloys which are completely solid; points between the two that of cooling alloys which are only partially solid; and the curves themselves show which solid compounds can be in equilibrium with the liquid and with each other at any temperature.

The cooling-curves of Roberts-Austen and Stansfield had shown that considerable evolutions of heat may occur in cooling alloys far below the temperature of solidification, indicating that changes are going on in the solid as well as in the liquid condition. Heycock and Neville carry their investigations below the temperature of complete solidification and study these changes also.

In the case of the copper-tin series of alloys they find that, according to the temperature and constitution of the liquid, crystals belonging to no less than six different types may separate, namely:—

α, a solid solution of Cu with less than 9 per cent. of Sn.
β, a solid solution of Cu with less than 27 per cent. of Sn.
γ, of which the constitution is not known.
δ, which probably has the composition Cu_4Sn.
η, which probably has the composition Cu_3Sn.
H, which probably has the composition CuSn.

Both β and γ are unstable at ordinary temperatures. The compound δ crystallises out of β or γ while they are already in the solid state, when the temperature falls sufficiently.

A glance through the 101 photographs of chilled and etched ingots which accompany Heycock and Neville's paper on this series of alloys shows how impossible it would be from the final composition of the solid alloy to ascertain the various stages through which it has passed during cooling; as the authors remark, it is of the nature of a palimpsest. For example, the alloy, containing 14 atoms of tin to 86 of copper, consists at 800° of α crystals in a ground-mass which probably contains β; it solidifies at about 775°; at 675° there are only β crystals; at 600° there are α and β crystals, but here α has crystallised out of β after it became solid; at 530° there is a much larger proportion of α; at 470° there are α crystals immersed in a mixture of α and δ into which the residual β has broken up on cooling.

If the course of events is so complex in an alloy of only two metals, how much more difficult must it be to decipher in the case of a mass of complicated silicates which are even more prone to form isomorphous mixtures, such as we have in a solid rock, not to mention the additional presence of aluminates, oxides, and sulphides. And yet geologists are accustomed to speculate freely about the crystallisation of rock constituents from the magma without taking account of anything save the final stage.

I cannot help thinking that the experimental method of Heycock and Neville will have to be applied to the study of slags and fused silicates if we are to trace successfully the evolution of rock species. The value of their work to geologists is not only that the results are skilfully interpreted by the light of modern physical chemistry, but primarily that it is experimental work upon actual crystallising materials.

Supersaturated Solutions.

I do not myself see how we can do otherwise than apply to the study of rock-magmas all that can be learnt from physical chemists concerning the behaviour of solutions, for though we cannot attain in laboratory experiments the high temperatures and great pressures at which rocks may have crystallised, there is no reason to believe that these introduce more than a difference of degree. The principles of equilibrium between the various crystallising components probably remain the same, whatever may be the temperatures and pressures at which they have solidified.

It must at the same time be confessed that most of the experiments upon which the modern theory of solutions has been built up have been conducted upon dilute solutions, whereas the problems of crystalline growth are concerned, not with dilute nor even with saturated solutions, but only with solutions which are supersaturated. There is some force in the objection of Doelter that the results of such experiments may not be directly applicable to crystallising slags.

For example, as I have already mentioned, doubt has been expressed in the case of silicate magmas, whether the substances in solution are the minerals about to crystallise or only their constituents; whether viscosity and supersaturation may not invert the theoretical order of their appearance; whether we are to take into account possible dissociation of the molecules or not; whether the presence of a common ion in these minerals is a factor which determines their mutual solubility. In fact, very little is known about the actual condition of the materials in a strong solution, although I do not know that there is any evidence available which forbids us to regard a solution about to crystallise as a mixture of liquids one of which is about to pass into the solid state.

But if little is known about the nature of strong and supersaturated solutions, a good deal may be learnt about their behaviour. Having complained that we need experiments in this field, I may perhaps be pardoned if I allude to some unpublished experiments of my own which relate to the general behaviour of crystallising liquids, and appear to me to explain two difficult problems in petrography. To such experiments the objection of Doelter does not apply.

The Metastable and Labile Conditions.

When a solution of any salt such as alum or sodium nitrate is allowed to crystallise at a uniform temperature the crystals will only grow so long as the solution is supersaturated; a crystal growing in the supersaturated solution will continue to do so until a condition of equi-

librium is attained. If the solution be kept at rest and maintained at a constant temperature, the crystal will continue to concentrate the liquid around itself and to withdraw solid material, until by diffusion of the impoverished liquid the whole mass is ultimately reduced to saturation, equilibrium is established, and the crystal ceases to grow; but most saturated solutions are so viscous that a very long time is required before this point is reached. Prolonged and vigorous stirring is required if the supersaturation is to be completely relieved within, say, a day; without stirring weeks may be required.

Further, it may be possible, as is well known, to keep a supersaturated solution in a sealed tube for years without change; and it is also possible to start crystallisation in such a liquid by dropping into it a crystal of the dissolved substance, or of one isomorphous with it, or sometimes by shaking it.

But it is, perhaps, not generally known that supersaturated solutions are of two sorts.

In 1897 Ostwald published some experiments upon supercooled liquids and supersaturated solutions, which were carried out with the object of showing how extraordinarily minute are the quantities of solid material capable of starting crystallisation in such liquids, but at the same time that they have a limit of size. He directed attention to the radical difference which probably exists between the state of a saturated solution which cannot crystallise spontaneously and that of the more strongly supersaturated solution which can do so.

The former is one in which crystallisation can either take place spontaneously or can be induced by stirring or shaking, or a variety of causes: this Ostwald calls the *labile* state. The latter is one in which crystallisation can only take place if a solid crystal of the dissolved substance, or a fragment of one, is brought into contact with the liquid: this he calls the *metastable* state. It is highly probable that no amount of stirring or shaking, or introduction of foreign substances, can make the metastable liquid crystallise.

Until recently no attempt to ascertain the exact limit between the metastable and labile states, or even to establish the existence of such a limit, had been successful, and practically no attention has been paid to the difference between them. Tamman, who measures the velocity of crystallisation by counting the number of the centres of growth or nuclei which appear in a supersaturated solution, does not recognise any distinction between the two states.

During the present year a number of experiments carried on by Miss F. Isaac and myself upon the strength of solutions from which crystals are growing have shown that it is easy to determine the changing concentration of a cooling solution by an optical method, to show that it passes into the labile state, and to ascertain the temperature at which the transition occurs. We have found, for example, that a solution containing 48 per cent. of $NaNO_3$ is saturated at 26°, is metastable between 26° and 16°, and crystallises spontaneously below that temperature; one containing 52 per cent. of $NaNO_3$ is saturated at 44°, and becomes labile at 35°.

In the metastable state inoculation by a solid germ of the dissolved substance, or of one isomorphous with it, is *necessary* in order to cause the liquid to crystallise; in the labile condition solid germs may be spontaneously generated from the liquid. Take, for example, a test tube filled with a solution of sodium-nitrate containing 48 parts of the salt in 100 parts of solution, which is metastable at ordinary temperatures; if crystals make their appearance in this solution it will only be because the dust of the room contains minute particles of sodium-nitrate which fall into the tube, or because crystals are deposited where drops have evaporated near the surface, and accordingly the first crystals appear at the surface of the liquid, and grow there until they are large enough to fall to the bottom. I find that such a solution, if enclosed in a sealed tube so as to prevent access of germs and evaporation, cannot be made to crystallise above the temperature of 16°, although it is supersaturated at all temperatures below 26°.

Again, let a hot solution of the same strength containing 48 per cent. of the salt be allowed to cool down while being stirred. If dust containing $NaNO_3$ can be excluded, the liquid will not crystallise until the temperature falls to 16°, when the solution passes from the metastable to the labile condition. A cloud of nuclei will then form throughout the liquid, and each will proceed to grow as a separate crystal; the immediate effect is to reduce the liquid to the metastable state so that no more crystals are produced, but each of these continues to grow from the liquid with which it is in contact.

If dust be not excluded, crystals may make their appearance upon the surface of the liquid and will soon sink; but even though they be stirred about actively in the solution the liquid as a whole remains in the metastable state until a temperature somewhat below 16° is reached, when the labile region is entered and a cloud of new crystals makes its appearance.

It follows, therefore, that in a cooling supersaturated solution, from which germs have not been excluded, there are normally two periods of growth: one in which a comparatively small number of isolated crystals are growing regularly, and a subsequent period in which a shower of small crystals is produced. Only if the rate of cooling be sufficiently slow, or the stirring be sufficiently violent, to keep the liquid in the metastable condition will there be no second period, no sudden precipitation of nuclei.

These events take place in all the aqueous solutions which I have examined, and I am surprised that they have not been discovered before. They afford a possible explanation of two common features of igneous rocks, and of slags—namely, the growth of comparatively large and isolated porphyritic crystals, or phenocrysts, and the appearance of the same mineral at two or more different periods. The origin and the arrested growth of phenocrysts have generally been attributed to sudden change of temperature, of pressure, or of hydration, and no other plausible explanation has been given, although, as has been sometimes pointed out, they may occur in batholites where there is no independent evidence of such changes. Pirsson has recognised the utter impossibility of the ordinary theory and has recently suggested that each mineral has its crystallisation interval during which it continues to grow, and that this is terminated by the increasing viscosity of the magma, which checks the supply of further material to the growing phenocrysts and establishes new centres of crystallisation. A similar explanation was adopted by Crosby for the quartz-porphyry of the Blue Hills. He expresses it by saying that owing to the increased viscosity the rate of cooling overtaxes the molecular flow, which cannot keep pace with the crystallisation. It is so difficult to find any satisfactory theory for the growth of phenocrysts that they have even been attributed to the effect of earthquake shocks.

Now in a silicate magma, in all probability, the temperature is sufficiently high to be that of the metastable condition, the rate of cooling sufficiently slow to keep the liquid in that condition for a considerable time, and the viscosity sufficiently great to prevent the growing crystals from sinking at once; we have, therefore, all the conditions favourable for the growth of *porphyritic* crystals; these must have generally originated throughout the liquid as spontaneous nuclei if the magma entered the labile state, or may have been started by inoculation or cooling at the margin if the magma as a whole remained in the metastable state. In the latter case suppose that further somewhat sudden cooling brings the magma to the labile condition, then there will be a sudden and spontaneous second growth of nuclei which will not be able to attain the dimensions of the porphyritic crystals; we have here all the conditions necessary for a *second generation* of one of the constituents of the rock.

It is not necessary, therefore, to suppose that changes of pressure played any very great part in these matters. I believe it will be found that considerations of temperature and solubility are far more important. Similarly in the case of the salt deposits van 't Hoff came to the conclusion that practically the only effect of changes of pressure is to displace the temperature of formation of the various compounds and not to alter their order or their nature; he estimates that this displacement is comparable with that of the melting points under the same agency, and in the case of the calcium-magnesium chlorides only amounts to a few thousandths of a degree for one atmosphere of pressure.

Perhaps when we can ascertain the temperature at which silicate magmas pass from the metastable to the labile condition we may use this knowledge to determine the exact temperature at which certain of their minerals crystallised.

Ordinary petrographical descriptions supply numerous examples of the difference between the metastable and labile conditions to anyone who will read them in the light of the suggestion which I have made; others are to be found in such experiments as those of Vogt or Doelter.

My own hope is that when more experiments have been made upon mixed *supersaturated* solutions it will be found that most, if not all, of the features of rock development are paralleled by the ordinary processes of crystallisation, but that motion, supersaturation, and supercooling are most important factors.

The very similarity between the differentiation of the alumo-alkaline and ferro-magnesian minerals on a small scale in the rock, and that of the alumo-alkaline (or salic) and ferro-magnesian (or femic) rocks themselves on a large scale, points to some similarity of origin.

In order to avoid burdening this Address with detail I have merely chosen the researches of van 't Hoff, Vogt, Doelter, and Heycock and Neville as illustrations of experimental work conducted on the lines of modern physical chemistry, and have omitted much that might have been mentioned; the valuable researches of Pelouze, Lagorio, Morozewicz, and Loevinson-Lessing, and the melting-point determinations of Joly I have not quoted, because they belong for the most part to an earlier period than that which I am considering, and have been discussed by Teall and other writers.

Many very interesting speculations I have passed over entirely, because my object has been to focus attention upon experimental evidence. I cannot help thinking that these speculations are often based upon chemical actions and equilibria that may be impossible; but we cannot criticise them for lack of evidence, and I return to my original statement that geology is only beginning to enter the experimental stage.

An earnest beginning is, however, being made. The researches on mineral and rock synthesis which I have already quoted are laying a solid foundation; and I see no reason why something of the sort which has been done by van 't Hoff and his collaborators for the aqueous deposits of Stassfurt should not ultimately be worked out for an igneous complex, though it may involve tenfold the labour and tenfold the time. We have already to welcome the establishment by the United States Geological Survey of a laboratory for the express purpose of applying to minerals and rocks the exact methods of modern physics and physical chemistry. The very suggestive research of Day and Allen upon the thermal properties of the felspars is a promise of the sort of work that may be expected from such laboratories.

I fear it will be only too evident to those who have given me their patience during this Address that I approach the problems considered in it from the point of view, not of the geologist or the chemist, but of the crystallographer, to whom the birth and growth of crystals are a study in themselves. Whether we watch with the microscope a tiny crystal growing from a drop of solution, or contemplate with the imagination the stages by which the fiery lavas of past geological periods sank to rest and crystallised, we view the same process; it is the transformation of liquid into crystal. Not necessarily into a solid, for recent research shows that there is no dividing line between liquid and solid; a plastic solid body may flow; a solid glass is only a supercooled liquid; witness, for example, the experiments of Adams on rocks, and of Tamman on supercooled liquids. The real primary distinction is between crystalline and non-crystalline material, and there is even good reason to believe that some crystals are liquid without ceasing to be crystals.

The properties of most rocks, of metals, alloys, ice, and many other substances are due to the fact that they consist of crystals, and the importance of the study of the latter is now, I trust, being brought home alike to chemists, physicists, geologists, and engineers in connection with problems relating to the strength, the movements, the origin and changes of what are usually called solids.

And so I close, as befits a student and teacher of crystallography, with the hope that renewed attention may be paid to this subject, and that it may attract the interest of many a keen intellect in South Africa. The higher scientific studies are now establishing themselves as an integral part of the educational and intellectual life of the country: this is in no small measure due to the South African Association; and we may hope that the visit of the British Association will be of some help to her younger sister in the task of diffusing a taste and an interest for the pure truths of science and the studies that they both hold dear.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY G. A. BOULENGER, F.R.S., V.P.Z.S., PRESIDENT OF THE SECTION.[1]

The Distribution of African Fresh-water Fishes.

I THINK I may ascribe the honour of having been chosen to preside over this Section to the fact that I have specially applied myself to the study of a large class of the animals of the part of the world in which we are for the first time assembled. The subject of the Address which it is the custom to deliver on such an occasion was therefore not difficult to choose—a general survey of the African fresh-water fishes from the point of view of their distribution.

It has repeatedly been pointed out that no division of the world can answer for all groups of animals, differences due to the period at which they appeared and to their ability or inability to spread over obstacles, whether of land or water, precluding any attempt to make their present distribution fit into the frames of the general zoogeographer. The great divisions of the earth, as outlined by our eminent Vice-President, Dr. Sclater, nearly half a century ago, and based mainly on a study of passerine birds, have therefore varied considerably according to the standpoint of the many workers who have followed in his footsteps. Fresh-water bony fishes particularly lend themselves to a uniform treatment, their principal groups having sprung up, so far as palæontological data teach us, about the same period in the history of the earth, and branched off in many directions within a geologically speaking brief lapse of time, most of them, besides, being regulated in their distribution by the water-systems. How greatly their distribution differs from that of terrestrial animals has long ago been emphasised. Thus, latitudinal range, so striking in many African reptiles, does not exist in fishes: the key to their mode of dispersal is, with few exceptions, to be found in the hydrography of the continent; and, as first shown by Dr. Sauvage, latitude and climate, excepting of course very great altitudes, are inconsiderable factors, the fish-fauna of a country deriving its character from the head waters of the river-system which flows through it. In this way, for instance, the Lower Nile is inhabited by fishes bearing a close resemblance to, or even specifically identical with, those of Tropical Africa, and strikingly contrasting in character with the land-fauna on its banks. Such being the case, it seems at first as if the geographical divisions of the fish-fauna were a matter of extreme simplicity, and that a knowledge of the river-systems ought to suffice for tracing areas which shall express the state of things. But we must bear in mind the movements which have taken place on the surface of the earth, and owing to which the conditions we find at present may not have existed within comparatively recent times; and this is where the systematic study of the aquatic animals affords scope for conclusions having a direct bearing on the physical geography of the near past. To mention two examples, the fishes of the Nile show so many specific types in common with those of the Senegal-Niger, now more or less completely separated by the Chad basin, that we felt justified in postulating a recent communication between these water-systems, which has been fully confirmed by the study of the Lake Chad fishes; whilst, on the other hand, the greater difference between the fishes of the Nile and those of the Congo basin, the waters of which interlock at pre-

[1] Slightly abridged.

sent in such a way that it is believed possible, at certain seasons, for a man in a boat to pass from the one into the other, points to the existence, until very recently, of a more effective separation. Such problems are of the greatest interest, and a more exact knowledge of the fishes will help towards their solution.

There is another aspect of the question of geographical distribution which has assumed special importance of late, especially in the writings of Prof. Osborn, Mr. Lydekker, and Dr. Scharff, and of which Dr. A. E. Ortmann's paper on the distribution of Decapod Crustaceans, published three years ago, may be taken as an example. One of the conclusions formulated therein is that "any division of the earth's surface into zoo-geographical regions which starts exclusively from the present distribution of animals without considering its origin must be unsatisfactory." But in certain groups of animals, possibly in most, the question of their origin is not easily settled; in the case of the African fresh-water fishes, for instance, we sadly lack all direct palæontological data, such as have sprung up lately in marvellous profusion in the case of the mammals, and notwithstanding the great progress in our knowledge of the changes that have taken place in the configuration of the world in Secondary and Tertiary times, which has been conveyed to a wide circle of readers chiefly through the luminous works of Neumayr, Suess, and de Lapparent, there is still much that is open to discussion. It must be admitted—and it is well to draw special attention to this point—that Dr. Ortmann's maps of the land-areas in past periods, which render his suggestive paper so attractive, cannot be accepted as the expression of well-established geological facts, and are, in some respects, gravely misleading. If I have attempted to deal with this subject on the lines laid down by Dr. Ortmann, whilst realising the want of many necessary data, palæontological and geological, on which to base conclusions, it is with a due sense of humility, being fully aware that the suggestions now offered must be regarded as mere speculations.

The time has come for a stock-taking of our immensely increased material, the previous accounts of the distribution of African fishes given by Dambeck in 1879, by Günther and by Sauvage in 1880, and by Palacky in 1895, no longer answering, even approximately, to our present knowledge, as may be seen by comparing the lists given by these authors with the one I have quite recently published in the *Annals and Magazine of Natural History* as a basis for the sketch here attempted.

How little we knew of the fresh-water fishes of Africa when the subject was dealt with by the above-named authors is exemplified by the enormous number of genera and species which have been discovered within the last few years, thanks chiefly to the enlightened activity of the Governments of Egypt and the Congo Free State, and to the initiative of Prof. Ray Lankester in organising explorations of the great lakes of Central Africa. The waters of the French Congo and Cameroon, the Niger, Abyssinia, and the interior of East Africa, have also yielded a large number of novelties; even the Nile, comparatively so well known, has been productive of many and remarkable additions to our knowledge. The importance of a better acquaintance with the fishes of the Lower Nile, a district believed to have been particularly well explored, can be measured by comparing the present data with those to which Prof. Gregory, on the faith of Dr. Günther's list, appealed to justify his theory of a direct connection in the past of the Upper Nile with the Jordan through a river flowing along what is now the Red Sea. To this question we shall revert presently.

Whilst the exploration of rivers and lakes has resulted in such a rich harvest, it remains a matter for serious regret that we should still be without any information as to the precursors of the African fishes. In spite of diligent search over a considerable portion of the great continent, no remains of any post-Triassic fishes have yet been discovered in Tropical and South Africa, and our acquaintance with Tertiary Teleosts generally is still almost as scanty and fragmentary as it was twenty years ago, although much has been done by Dr. Smith Woodward in elucidating the affinities of such remains as have been exhumed. In the circumstances we have to fall back on our imagination to explain the origin of the most important groups characteristic of the present African fish-fauna, and much hazardous speculation has been indulged in. Thus, without any sort of evidence, the Cichlid Perches of Africa have been supposed to emanate from ancestors inhabiting hypothetical Jurassic or Cretaceous seas extending over Central Africa, whilst connecting land areas have been too freely postulated to account for the resemblance between the fishes of Africa and Tropical America, and antarctic continents devised to explain the presence of Galaxias in South Africa. To these suggestions I shall refer further on when dealing with the distribution of the families to which they were intended to apply. Although it is highly desirable that zoologists should base their theories of geographical distribution upon geological data, I think we must regret the growing tendency to appeal to former extensions of land or sea without sufficient evidence, or even contrary to evidence, in order to explain away the riddles that offer themselves.

Twenty-five years ago a list of the African fresh-water fishes would have included the names of about 350 species (Günther gave the number as 255 only), some fifty of which have since lapsed into the synonymy, whilst at the present day we are acquainted with 976 species, referable to 185 genera and forty-three families. Of the latter five were then unknown, or unknown to have representatives in this part of the world. The forty-three families are here enumerated, with an indication of the number of genera and species according to the most recent census:—

CHONDROPTERYGII.

PLAGIOSTOMI.

1. Carchariidæ, 1, 1.
2. Pristidæ, 1, 1.

CROSSOPTERYGII.

CLADISTIA.

3. Polypteridæ, 2, 11.

DIPNEUSTI.

4. Lepidosirenidæ, 1, 3.

TELEOSTEI.

MALACOPTERYGII.

5. Elopidæ, 2, 3.
6. Mormyridæ, 11, 108.
7. Notopteridæ, 2, 2.
8. Osteoglossidæ, 1, 1.
9. Pantodontidæ, 1, 1.
10. Phractolæmidæ, 1, 1.
11. Clupeidæ, 6, 7.
12. Salmonidæ, 1, 1.
13. Cromeriidæ, 1, 1.

OSTARIOPHYSI.

14. Characinidæ, 20, 93.
15. Cyprinidæ, 12, 202.
16. Siluridæ, 37, 187.

APODES.

17. Anguillidæ, 1, 6.

HAPLOMI.

18. Galaxiidæ, 1, 2.
19. Kneriidæ, 1, 2.
20. Cyprinodontidæ, 5, 39.

CATOSTEOMI.

21. Gastrosteidæ, 1, 1.
22. Syngnathidæ, 2, 3.

PERCESOCES.

23. Scombresocidæ, 1, 1.
24. Atherinidæ, 2, 3.
25. Mugilidæ, 2, 13.
26. Polynemidæ, 3, 3.
27. Sphyrænidæ, 1, 1.
28. Ophiocephalidæ, 1, 3.
29. Anabantidæ, 1, 14.

ACANTHOPTERYGII.

30. Centrarchidæ, 1, 3.
31. Nandidæ, 1, 1.
32. Serranidæ, 6, 8.
33. Sciænidæ, 1, 1.
34. Pristipomatidæ, 2, 2.
35. Sparidæ, 1, 1.
36. Scorpididæ, 1, 3.
37. Osphromenidæ, 1, 1.
38. Cichlidæ, 30, 179.
39. Pleuronectidæ, 2, 2.
40. Gobiidæ, 2, 31.
41. Blenniidæ, 3, 3.

OPISTHOMI.

42. Mastacembelidæ, 1, 23.

PLECTOGNATHI.

43. Tetrodontidæ, 1, 4.

In discussing the distribution of the fresh-water fishes it is necessary to divide them into four principal categories:—

(1) Those living part of the year in the sea. This category is again subdivided into anadromous forms, breeding in fresh water (ex. some Clupea), and catadromous forms, breeding in salt water (ex. Anguilla).

(2) Those living normally in the sea, but of which certain colonies have become land-locked, or have separated themselves from the marine stock still represented on the neighbouring coast (ex. some Gobiidæ and Blenniidæ).

(3) Those which, although entirely confined to fresh waters, have as nearest allies species living in the sea, and which there is reason to regard as more or less recently derived from marine forms (ex. Galaxiidæ, Tetrodontidæ).

(4) Those belonging to families entirely (ex. Mormyridæ, Characinidæ) or chiefly (ex. Siluridæ, Cyprinodontidæ) restricted to fresh waters.

The forms of the first and second categories may be entirely neglected in dealing with the distribution of fresh-water fishes. Their range is regulated by the sea, and they must be dealt with in conjunction with littoral forms. Eighty-six species in the list of African fresh-water fishes belong to these categories.

The third category is of secondary interest in the history of the fresh-water fauna; but, as in the case of Galaxias, forms referred to it may give rise to discussion.

It is with the members of the fourth category that we shall mainly deal in the portion of this Address which is devoted to the origin and mode of dispersal of the African fishes.

THE POLYPTERIDÆ.—This is incontestably the most remarkable family of African fishes. Entirely restricted to Tropical Africa and the Nile, without any known near allies, living or extinct, its history is one of the greatest riddles in ichthyology. From the evolutionary point of view, no group is of greater interest, owing to its probable relation to the Chondropterygians or Elasmobranchs, to the Osteolepid Crossopterygians, out of which the Lung-fishes seem to have been evolved, and to the earliest pentadactyle vertebrates, the Stegocephalous Batrachians. Although generally brigaded by modern systematists with the Osteolepida in the order Crossopterygii, it is still doubtful whether it should not rank as a distinct order, Cladistia of Cope, the characters which differentiate it from these early Teleostomes being perhaps of greater importance than those which separate these from the Dipneusti. Until we have some proof to the contrary, we are justified in regarding the Polypteridæ as having arisen in Africa from fresh-water ancestors, themselves derived from early Mesozoic types which are entirely hypothetical.

THE LEPIDOSIRENIDÆ.—Protopterus in Africa and Lepidosiren in South America are specialised modifications of the Ceratodontidæ, still represented by one species in Australia, which have left remains in Triassic, Rhætic, Jurassic, and Cretaceous rocks of Europe, North America, Patagonia, North and South Africa, India, and Australia. The distribution of the Ceratodontidæ has therefore been, at different periods at least, a world-wide one, and we should feel justified in assuming the living representatives of the Lepidosirenidæ to have been evolved out of this family independently in Africa and in South America. On the other hand, in view of the old age of the group, there is no reason why the Lepidosirenidæ should not have passed from one of the present continents into the other when they were connected by land. As Protopterus is a less specialised type than Lepidosiren, the probabilities would then be that the former originated in Africa. Mr. Lydekker, in his "Geographical History of Mammals," states his opinion that Lepidosiren reached its present habitat by way of Africa. The mode of life of these fishes renders them less dependent on hydrographical systems, and the distribution of the species, which cannot yet be traced in a satisfactory manner, is evidently very different from that of other groups.

THE MORMYRIDÆ.—This extraordinary group, of which so many new and remarkable types have been discovered within the last few years, especially in the Congo, is peculiar to the fresh waters of Tropical Africa and the Nile. Its morphology shows it to be highly specialised from some very lowly Teleostean ancestor. This I believed to be found in the Albulidæ, a family already represented in Cretaceous seas, and of which one species still occurs on the West Coast of Africa. But Dr. Ridewood, who has recently made a much more careful study of the cranial characters of the two families, is unable to support the suggestion of a direct descent from the Albulidæ. It nevertheless remains probable that the Mormyridæ were derived from forms more closely allied to the known Albulidæ than to any other family with which we are acquainted, and which no doubt lived in Cretaceous seas; and we may therefore assume that the Mormyridæ originated in Africa, and were evolved out of Cretaceous marine ancestors.

THE NOTOPTERIDÆ.—This is another eccentric family, having many points in common with the Mormyridæ and with the North American Hyodontidæ. It is represented by five species, three of which live in the Indo-Malay region and two in Tropical Africa. Its derivation is still a mystery. The fact that its most specialised form (Xenomystus) is African, and that a species differing but little from the living Notopterus occurs in fresh-water deposits in Sumatra, which are regarded by some geologists as of Middle Eocene age—although, as stated further on *à propos* of the Cyprinidæ, there is reason for regarding them as Miocene, or even later—justifies us in believing, until further palæontological evidence be available, that the African forms are immigrants from the East.

THE OSTEOGLOSSIDÆ.—An archaic type of Teleosteans, now represented by two genera in South America, by one in Australia and the Malay Archipelago, and by a fourth in Tropical Africa and the Nile. Excellently preserved fossils from the Middle Eocene of Wyoming (Dapedoglossus) are most nearly allied to, but more generalised than, the Australian-Malay genus; whilst the less satisfactorily known British Lower Eocene Brychætus appears nearer to the South American Arapaima. The African genus Heterotis is the most specialised form. The Osteoglossidæ are evidently an ancient group, now in process of extinction, which once had a very wide distribution. The fact of the only known fossil representatives being from North America and Europe does not seem sufficient evidence of the northern origin of the family, as suggested by Mr. Lydekker.

PANTODONTIDÆ, PHRACTOLÆMIDÆ, CROMERIIDÆ.—Three monotypic families peculiar to Africa. The first bears a near relationship to the Osteoglossidæ, and was probably derived from them; but the two others, discovered within the last few years, are so aberrant and isolated among the Malacopterygians that we are absolutely in the dark as to their possible origin.

THE CHARACINIDÆ.—This is one of the larger groups of African fishes—with ninety-three species, referred to twenty genera, mostly from the Nile and Tropical Africa, as far east as the great lakes, but only very sparsely represented in East and South Africa.

One of the most striking features of the South American fresh-water fish-fauna is the extraordinary number and variety of forms of the Characinidæ, unquestionably one of the most lowly and generalised groups of exclusively fresh-water Teleosts. There occur in that part of the world as many as 500 species (about two-fifths of the whole fresh-water fish-fauna), divided among some sixty genera. The carnivorous forms predominate, but the herbivorous or semi-herbivorous are also very numerous. The latter would evidently compete with the Cyprinids, their near but more specialised relatives, which are so numerously represented in North America; and it is a remarkable fact that not a single Cyprinid is known to extend further south than Guatemala.

Although palæontology has taught us nothing respecting the Characinids, we have reason to assume, from the morphological point of view, that they were the precursors of the Cyprinids, which, we know, were already abundantly represented in North America and Europe in Lower Tertiary times, when the Isthmus of Panama was under the sea. When, in the Miocene, North and South America became re-united, the waters of the latter part of the world must have been already so fully stocked with Characinids as to prevent the southern spread of the Cyprinids. This is the only explanation that can be offered of the total absence of Cyprinids in South America, considerations of climate being of no avail in view of their distribution all over Africa. If, therefore, the Characinids existed in profusion in South America before the Miocene period, we are justified in claiming for them a high antiquity, and by putting it at the Upper Cretaceous we need not fear going too far back.

THE CYPRINIDÆ.—These fishes, as mentioned above, are very closely related to the preceding, and there is every reason to believe the former to be derived from the latter. Their least specialised genera (Catostominæ) are now found in North and Central America (about sixty species), whilst three species, referable to the same genera, inhabit Eastern Siberia and China. These Catostominæ are known to have had representatives in the Eocene of North America, whilst the more specialised Cyprininæ, which

constitute the great bulk of the family both in the new world and in the old, have left remains in the Oligocene and later beds in North America and Europe. It is, therefore, highly probable that the Cyprinids originated as a northern offshoot of the South and Central American Characinids, and thence spread to Eastern Asia, at least as early as the Upper Eocene. By the time (Miocene) they had reached India, where they now form the great majority of the fresh-water fishes, Africa had been connected with it by a wide belt of land, and no obstacle prevented their western extension. This comparatively recent migration accounts for the practical identity of the genera and the often very close affinity of the species of the Cyprinids of India and Africa. At the same period the land-area connecting India and Africa with Madagascar had disappeared, and the Cyprinids never reached that great island, where no doubt they would have thriven, if we judge by the results of the introduction by man of the gold fish, said to be in process of strongly reducing the numbers of the native Malagasy fresh-water fishes with which it is in a position to compete. Competition is always an important factor in the distribution of a group of animals, and the confinement of the Characinids to the waters of the western and central parts of Africa at the time of the immigration of the Cyprinids from the east must be the explanation of the comparative abundance of the latter and the scarcity of the former in those parts of the continent east of the Rift Valley which are not drained by rivers flowing from the central parts. The Cyprinids must have spread more rapidly than the Characinids, and being also less partial to heat they have thriven in the waters of South Africa, where at present only two species of Characinids—both carnivorous forms—are known to extend south of the Zambesi system. Of the 202 species recorded from Africa thirteen are found in North-West Africa, sixty-three in East Africa (exclusive of the Zambesi), and twenty-one in South Africa.

THE SILURIDÆ.—This large family is almost cosmopolitan in tropical and warm regions; and although the great bulk of the species are restricted to fresh waters, a certain number (chiefly of the sub-family Ariinæ) occur on the coasts and in the estuaries. Morphologically these fishes are so closely allied to the Characinidæ and Cyprinidæ that we must assume them to have been evolved from a common ancestral stock, probably in Cretaceous times; but connecting forms such as we should expect to find in deposits of that age are still unknown. The Silurids appear in the Lower Eocene estuarine beds of England and France, as forms closely related to the living Ariinæ and Bagrinæ, and further allied forms follow in the Middle Eocene of various parts of Europe and North America. In the Upper Eocene of Lower Egypt estuarine deposits contain well-preserved remains of forms which appear to be only specifically separable from the Bagrus still living in the Nile. The general distribution of these fishes was, therefore, in early Tertiary times very much the same as it is at present, and palæontology offers us no clue as to where they originated.

The exclusively fresh-water Silurids now found in Africa are all generically distinct from the South American forms, whilst the West African species that enter the sea belong to the same genus (Arius). The two exclusively fresh-water Silurids found in Madagascar show closer affinity with the African than with the Indian forms, and may have immigrated from Africa in the early Tertiary times through the bridge which then existed, unless they have been derived from marine types, which is quite possible.

THE GALAXIIDÆ.—Two small fishes originally described by F. de Castelnau as Loaches, and now referred to Galaxias, occur on the flats near Cape Town and in the Lorenz River, some twelve miles from its mouth in False Bay. They are of special interest as belonging to a family and genus long believed to be exclusively confined to fresh waters and characteristic of the extreme south of America, New Zealand, and Southern Australia. After Dr. Steindachner had first recognised the true affinities of the Cape species, Prof. Max Weber was inclined to regard this interesting discovery as affording a new argument in favour of the past antarctic continent on which so much has been written. But Dr. Wallace was nearer the truth when he suggested that a land connection within the period of existence of one species of fish, viz. *Galaxias attenuatus*, known from Chili, Patagonia, Tierra del Fuego, the Falkland Islands, New Zealand, and Southern Australia, would have led to much more numerous and important cases of similarity of natural productions than we actually find, and that we must rather look to the transport of the ova across the southern sea to explain this very remarkable distribution. A better acquaintance with the Galaxias has confirmed Dr. Wallace's supposition, as it is now an established fact that some species live in the sea.

As the early Tertiary "Antarctica," as designed by Prof. H. F. Osborn, does not involve South Africa, the presence of species of Galaxias at the Cape cannot, even on that hypothesis of continental extension, be explained except on the assumption of their marine origin.

THE KNERIIDÆ.—A monotypic family with two species, one from Angola, the other from East Africa. These little fishes are related to the Pikes, Esocidæ; and there is no reason that I can see against their being possibly derived from them, in which case they would be of northern origin, the Esocidæ, now confined to the northern hemisphere, being known from fresh-water deposits in Europe as far back as the Oligocene.

THE CYPRINODONTIDÆ.—The members of this large family are mostly Central and South American. They are comparatively few in Africa, but have representatives in every part, and also in Madagascar and the other islands of the Indian Ocean. Although principally restricted to fresh waters, not a few species are known to live in brackish water, whilst examples are known of their occurring far out at sea.

THE OPHIOCEPHALIDÆ AND ANABANTIDÆ.—Unknown fossil, and now restricted to Africa and South-Eastern Asia, we have no means of telling in what part of the world these two closely allied families originated. The Anabantidæ are more numerous in species, and these are of a more generalised type, in Africa than in Asia.

THE NANDIDÆ.—The recent discovery of Polycentropsis in the Lower Niger has added a genus to a small family previously known to be represented by three genera in South-Eastern Asia and by two in the northern parts of South America. The latter are more nearly related to the African genus than the former. Too little is known of the habits of these fishes to decide whether the hypothesis of a migration across the Atlantic, in the days when a shallow area with a string of islands connected the old world and the new, answers for their distribution. Their systematic position—specialised Perciformes—is against the assumption of their having existed in Cretaceous or early Eocene times. No fossil forms are known.

THE OSPHROMENIDÆ.—The only African representative, the genus Micracanthus, with a single species in the Ogowé, is hardly separable from the genus Betta, which, with six other genera, is characteristic of the Indo-Malay region and China. Palæontology gives no information on the earlier distribution of these highly specialised fishes. That a type so well organised for adapting itself to all sorts of waters, and so ready to acclimatise itself in any part of the tropical or subtropical countries where it has been transported by man, should have so restricted a range seems remarkable. Were it not for the existence of this African form, far away from the other members of the family, one might have felt inclined to look upon the Osphromenidæ as a very recent group, which has not had time to spread far from its original centre in South-Western Asia.

THE CICHLIDÆ.—As regards the number of species (179) this family ranks next to the Cyprinidæ (202) and the Siluridæ (187) in the African fresh-water fish-fauna, and, like these, it has representatives nearly all over the great continent. Although Cichlids may thrive in inland waters of considerable salinity, they are not known to have ever been found in the sea, even near the mouths of rivers. The facility with which they establish themselves in isolated waters, often untenanted by other fishes, such as wells in the Sahara, salt-water pools in the interior of East Africa, &c., has long been known, but by what agency this has been effected remains unexplained. Quite recently Dr. Lönnberg has reported on the exploration of a small

isolated lake of volcanic origin on the Cameroon mountain, a lake 200 feet above sea-level, without any outlet, and situated about twelve miles from the nearest river and twice as far from the sea-shore. This lake was found to have a fish-fauna consisting exclusively of Cichlids, belonging to three genera and five species, two of which have been described as new.

The great bulk of the family inhabits Africa, including Madagascar, and America, from Texas to Montevideo; the number of generic types is greater, although the species are only slightly in excess, in the former than in the latter part of the world. Seven species inhabit Syria, three of these being also found in the Nile, and three are known from India and Ceylon. The American and Indian genera are all distinct from the African. A great number of species (fifty-five), all but one endemic, inhabit Lake Tanganyika, of which they form a little more than two-thirds of the fish-fauna; and many of these species belong to distinct genera, showing specialisation to a remarkable degree. Out of thirty recognised genera of African Cichlids, as many as fifteen are believed to be peculiar to Tanganyika. Lake Nyassa, with the Upper Shiré, possesses also some remarkable endemic genera; but they are only four in number, and the number of species recorded up to the present does not exceed twenty-two. The rest of the species are mostly from West Africa and the Congo basin; but a few, referable to the two most widely spread genera, are found in East and South Africa. Madagascar has only four species, two belonging to an endemic genus, whilst each of the two others is referred to a widely distributed African and Syrian genus.

No fossils are known that agree closely with any of the recent genera, but a type of Perciforms, described by Cope as Priscacara, from Middle Eocene fresh-water beds in North America, presents all the characters which we should expect to find in the direct ancestors of the modern Cichlids, differing from the living forms in the presence of vomerine teeth, a serrated præ-operculum, and apparently eight branchiostegal rays. It has twenty-four vertebræ, a number lower than is found in most of the recent genera; and this indication is of importance for reasons that must be explained somewhat fully.

The lower Teleosteans (Malacopterygii and Ostariophysi, often united under the term "Physostomi") mostly have a high number of vertebræ; but when we pass on to the higher Acanthopterygii, we find very frequently, among most diverse families, the number reduced to twenty-four. That this number should occur with such frequency has struck many ichthyologists since Dr. Günther first directed attention to it, more than forty years ago, pointing out at the same time that in the Labridæ this number is almost constant in the tropical genera, whilst those genera which are chiefly confined to the temperate seas of the northern and southern hemispheres have an increased number. It has since been shown by Dr. Gill and by Prof. Jordan that this generalisation holds true of several other families of Acanthopterygians, and the latter authority, when discussing the subject at some length, came to the opinion that the state of things could be explained, from an evolutionary point of view, on the assumption that competition among various marine fishes being greater within the tropics has resulted in greater specialisation, by which the originally high number of vertebræ has been reduced. It is difficult, however, on this assumption to account for the fact that in so many cases the reduction should have resulted in the number twenty-four—neither one more nor one less—and this repeated in many families belonging to the same sub-order but otherwise only remotely related to one another. Three years ago, when dealing with the affinities of the flat-fishes, Pleuronectidæ, I was struck by the discovery that, in the unquestionably least specialised genus, Psettodes, the vertebræ are twenty-four in number, the other known genera having from twenty-eight to sixty-five, and that the numbers increased along the most probable lines of evolution. A consideration of other families, and of the fossil forms in which the number of vertebræ has been ascertained, soon convinced me that this rule also applies to them, and that the order of evolution had in every case to be reversed from that assumed by Prof. Jordan, whose interpretation I had previously accepted as correct. As a result of my investigation into this question I believe that the frequent occurrence of twenty-four vertebræ is due to the original Acanthopterygians having presented this number, that it has been retained in the more generalised members of the families which have branched off from them, and increased or, more seldom, reduced in the course of evolution.

The view which I entertained when first studying the Cichlids of Lake Tanganyika must be abandoned, and the direction of the supposed lines of evolution reversed, together with the signification given by me to the characters of increased number of dorsal and anal rays, or of multiple lateral lines which go more or less hand in hand with the increase in the vertebral segments. I must therefore repudiate the statement, first made by me in describing some of the new genera discovered by Mr. Moore in Lake Tanganyika, that they show features of generalisation, the contrary being the case. This has been shown by Dr. J. Pellegrin, who has recently published a monograph of the whole family Cichlidæ, in which he has very ably dealt with the question of the interrelation of the various genera from the phylogenetic point of view.

Two theories have lately been put forward as to the origin of the African Cichlids.

According to Mr. Moore, to whom we owe the discovery of so many new forms in Lake Tanganyika, the Cichlids are of marine origin, and penetrated into a hypothetical Central African sea in præ-Tertiary times. But as no Perciform fish of any sort is known earlier than the Upper Cretaceous, and no Perch, in the widest sense, before the Lower Eocene (Prolates), the possible existence at that remote time of so specialised a type of Perches as the Cichlids is absolutely contrary to palæontological evidence. Further, such an explanation is unsupported by any geological data, no trace of Jurassic or Cretaceous deposits having been found on the plateau of Central Africa, notwithstanding much search over a considerable portion of the Congo State. It is impossible to imagine that such a sea could have existed without leaving any sedimentary deposits whilst its relics were being preserved in Lake Tanganyika. Besides, the distinguished Belgian geologist, Prof. J. Cornet, who has paid special attention to this question, and has himself surveyed a considerable part of the territory of the Congo State, regards the Tanganyika as by no means a very ancient lake, its formation not dating back beyond Miocene times. I may also here point out that Mr. Moore's interpretation of the affinities of the so-called "halolimnic" Mollusca has not received any support from those best able to judge of its merits. Mr. E. A. Smith, from the recent conchological, and Mr. Huddleston, from the palæontological point of view, have recently discussed his conclusions, with which they are unable to agree. I need hardly add that the discovery since the publication of the "Tanganyika Problem" of the Medusa *Limnocnida tanganicae* in Lake Victoria has dealt a further blow to Mr. Moore's theory.

As regards the origin of this Medusa, recent palæontological discoveries afford a much more rational explanation of the presence in Tanganyika of a Cœlenterate of unquestionably marine derivation. The highly important finds of fossils between the Niger and Lake Chad by the English and French officers of the Boundary Commission, which have been reported upon by Prof. de Lapparent, Mr. Bullen Newton, and Dr. Bather, have conclusively established the existence of Middle Eocene marine deposits over the Western Soudan, and the Egyptian and Indian character of these fossils, as well as of others previously obtained in Cameroon and Somaliland, justifies the belief in a Lutetian (Middle Eocene) sea extending across the Soudan to India. In fact, as stated by Mr. Newton, the palæontological evidence seems to prove that the greater part of Africa above the equator was covered by sea during part of the Eocene period. On this sea retreating northwards, after the Lutetian period, Medusæ became land-locked and gradually adapted themselves to fresh water: they had not far to travel to find themselves in what are now the Nile lakes, and later, through the changes which Mr. Moore himself has shown to have taken place in the drainage of Lake Kivu, they were easily carried into the Tanganyika—probably at no very remote time—and maintained themselves to the present day. I understand that the Medusa reported from Bammaku, Upper Niger, in 1895, but still

undescribed, has been re-discovered by Budgett, and is now being studied. Should it prove to be related to the Tanganyika species, it would also have to be regarded as a relic of the same Eocene sea, and it would add further support to the very simple explanation which I have ventured to offer of a case which seemed so tremendously puzzling in our previous state of ignorance of the geological conditions of Africa between the equator and the tropic of cancer.

As explained by Prof. Cornet, Tanganyika has been until very recent times without an outlet. The Lukuga, which drains into the Congo, was only formed after Lake Kivu became, owing to volcanic eruption, a tributary of the Tanganyika through the Rusisi River. The greater or less salinity of the water of a lake without an outlet is a matter of course, and therefore Tanganyika was for a long time a salt lake. Its water is still, Mr. Moore says, somewhat salt. No wonder that the Cichlids, which elsewhere in Africa show no aversion to such conditions, and which somehow or other contrive to settle into isolated waters, should have been among the first inhabitants of the lake, where, without having to face competition with other types of fishes, they throve and became differentiated into a multitude of genera. When the hydrographical conditions changed and the water gradually lost its salinity, first on the surface and later at greater depths, an influx of other forms of fish-life (Polypterus, Characinids, Cyprinids, Silurids, &c.) penetrated into the lake, some from the Nile system through the Rusisi, others from the Congo up the Lukuga. This explains well enough the character of the Tanganyika fish-fauna. The Cichlids, the oldest inhabitants of the lake, nearly all belong to endemic species, many of which constitute genera represented nowhere else; whilst the fishes of other families, later immigrants, all belong to widely distributed genera, and several of them even to species also found either in the Nile or in the Congo, or in both these river-systems.

The other theory is that the Cichlids have originated as fresh-water fishes in Eocene times in America and have crossed the Atlantic by a bridge which then connected South America with Africa. This is the explanation given by Dr. Pellegrin. He admits that we have no indication of any near allies of these fishes before the Middle Eocene (Green-River beds of North America), and, basing his statement on the last edition of Prof. de Lapparent's "Traité de Géologie" (1900), he says it seems to be beyond doubt that during the Lutetian period, which immediately followed that at which the earliest Cichlids were known to live in the fresh waters of America, a vast continent extended between South America and Africa. Should this have really been the case, the question of the distribution of the Cichlids could be regarded as settled. But I cannot satisfy myself that there is any geological evidence to support this view.

This third hypothesis has this advantage over the two others, that it does not postulate any land-areas in late Eocene or Miocene times, for which there is at present no sufficient evidence, nor a præ-Tertiary and marine origin for the family Cichlidæ, which is wholly improbable and receives no support from palæontology.

On the other hand, it is undeniable that the hypothesis of a South Atlantic land communication in the Eocene has much in its favour, and when this is really established all difficulty in explaining the distribution of the Cichlidæ will have disappeared. In the meanwhile, to use an appropriate metaphor, we must not construct bridges without being sure of our points of attachment, otherwise they are liable to collapse as geological knowledge progresses.

THE MASTACEMBELIDÆ.—At present we are acquainted with thirty-eight species of Mastacembelus: fourteen from the Indo-Malay region, one from Syria and Mesopotamia, and twenty-three from Tropical Africa. The distribution of these fishes, the fossil remains of which are still unknown, has probably once been a continuous one, climatic and hydrographic conditions possibly accounting for the present discontinuity. We have no data from which to decide whether the Mastacembelids first appeared in Asia or in Africa, or simultaneously in both parts of the world, as is quite possible on the assumption that the family originated in the Eocene sea extending from the Western Soudan to India.

This concludes our review of the affinities and past history of the principal fresh-water types which characterise the present African fish-fauna. We have endeavoured to show that a Tertiary land connection between Africa and South America is not absolutely necessary to explain the many points of agreement between the fresh-water fishes of these two parts of the world, as has been postulated by many writers. Besides, there are still some who hold, as does Prof. G. Pfeffer—whose interesting essay on the zoogeographical conditions of South America, from the point of view of lower vertebrates, appeared after this Address had been written—that a former subuniversality of distribution will afford a solution to many of these problems without necessitating such a land-connection, as exemplified by the past distribution of the Pleurodiran Chelonians. In this review we have summarised many previous hypotheses and added a few, but in every case with a feeling of dissatisfaction, fully realising, as we do, the futility of speculations in the present state of the two great branches of knowledge, geology and palæontology, on which the solution of these questions must ultimately rest.

We may now pass on to the realm of facts, and survey in the briefest manner the waters of the great continent as they appear after the many discoveries which have of late so greatly increased our knowledge of the African fishes.

In the present state of our knowledge of the fresh-water fishes Africa may be divided into five sub-regions, the discussion of the further subdivision of which would exceed the limits of this Address:—

(1) The North-Western Sub-region, or Barbary, and the Northern Sahara, properly forming part of the Palæarctic region.

(2) The Western-Central Sub-region, with all the great rivers and lakes, extending to the Nile Delta and the mouth of the Zambesi, for which the term Megapotamian Sub-region has been suggested to me by Dr. Sclater.

(3) The Eastern Sub-region—Abyssinia, with the upper tributaries of the Blue Nile, and the countries east of the Rift Valley and north of the Zambesi.

(4) The Southern Sub-region—all the waters south of the Zambesi system.

(5) Madagascar.

The smaller islands of the Indian Ocean have a fresh-water fish-fauna so insignificant that they may be entirely neglected in a broad division of the African region.

I. THE NORTH-WESTERN SUB-REGION.

In its deficiency in rivers of permanent flow Barbary has much in common with South Africa, and these two parts of Africa in their fish-fauna present a somewhat analogous example to that on which the now exploded theory of bipolarity was founded. Swelling to foaming torrents in the rainy season or after a storm, reduced to series of pools connected by tiny streams at other times, the watercourses are evidently unsuited to fish-life; and it is not surprising that, apart from a certain number of forms adapted to live in stagnant, often strongly saline, waters, the fishes should be so few in kind. But they make an interesting assemblage, in which it is easy to discover forms unmistakably suggestive of the præ-Pliocene times when the sea had not burst through the Straits of Gibraltar, mixed with others of decidedly Africo-Indian or Oriental affinities.

The number of species from inland waters, whether fresh or salt, hitherto recorded from this part of Africa, amounts to thirty or thirty-one only. Of these thirteen are Cyprinids, which may all be regarded as of northern or eastern immigration. Four of the Barbels show European affinities, one of them being found also in Spain, whilst the seven others belong to a section of the genus largely represented in Southern Asia and East Africa, but only known in West Africa from Cameroon. A species of Varicorhinus, recently discovered in Morocco, has similar affinities, the genus being known from South-Western Asia, Abyssinia, and Lake Tanganyika. A small somewhat aberrant species of the South-Western Asian genus Phoxinellus has been described from the Algerian Sahara, whilst an Alburnus from the Tell (originally placed in the genus Leuciscus) is also the sole representative in Africa of a genus inhabiting Europe north of the Pyrenees and

Alps and South-Western Asia. With two exceptions, all the Cyprinids are confined to the northern watershed of the Atlas, in which varieties of our River Trout and our Stickleback also occur; but *Barbus callensis* and the Phoxinellus occur also in the Algerian and Tunisian Sahara, showing that, as in other groups of animals, no sharp delimitation can be drawn between the Palæarctic and Æthiopian regions of Barbary.

Of three Cyprinodonts one, from the high plateaux, inhabits also Spain; another, more generally distributed, is known from Sicily, Syria, and North-East Africa; whilst the third, remarkable for the absence of ventral fins, is monotypic of a genus named Tellia—a misnomer, as it is not found in the Tell, but on the high plateaux of Algeria, at altitudes of from 2000 to 3000 feet, not 8000, as stated by Danbeck.

Three Cichlids are known from the Northern Sahara, one, a Tilapia, being restricted to Eastern Algeria and Tunisia, whilst the two others, a Hemichromis and a Tilapia, extend to Lower Egypt, and are besides widely distributed in Tropical Africa. The Cichlids, along with the Cyprinodon, the Barbus, and the Phoxinellus mentioned above, are often ejected by artesian wells, and the fact has given rise to much discussion. The latest investigator of this phenomenon, the distinguished engineer, M. George Rolland, confirms the opinion, expressed by the late Sir Lambert Playfair and M. Letourneux in 1871, that these fishes normally live and breed in the lakes and wells exposed to air and light, and that their presence in the underground sheets of water with which the lakes communicate is merely an episode, and as it were an incident in the voyages which they undertake from one opening to the other. There is therefore no justification for the term "realm of the Trogloichthydæ" which has been proposed by Dambeck for North-West Africa.

The other fishes which complete the list are of direct marine derivation, as the anadromous Shad and the catadromous Eel and Grey Mullets, or such as have recently adapted themselves to permanent existence in fresh water, like the Syngnathus discovered by Sir L. Playfair, the Atherina, which occurs also in various fresh-water or brackish lakes in Southern Europe and Egypt and in the Caspian Sea, two Gobies and a Blenny, the latter being also known from fresh waters in the South of France and in Italy. The occurrence of an otherwise strictly marine species of Blenniids (*Cristiceps argentatus*) in the fountain of Ain Malakoff, in the high plateaux of Algeria, rests on the testimony of a naturalist of Algiers and needs confirmation.

II. THE MEGAPOTAMIAN SUB-REGION.

The Nile, the Niger, the Gambia and the Senegal, the Congo, and the Zambesi, with their numerous Mormyrids, Characinids, Silurids, and Cichlids, have much the same general character, which points to many of the generic types having radiated from a common centre of origin, no doubt in those great central lakes which are believed to have existed in Middle Tertiary times. Lake Chad, the ichthyic fauna of which was until quite recently unknown, represents the dwindling remains of a larger basin which communicated until comparatively recent times with both the eastern and western river-systems, thus accounting for the great resemblance between the fishes of the Nile and those of the rivers of the Atlantic watershed north of the Cameroons, 46 species out of 101 known from the Nile (without the great lakes by which it is now fed) being also found in the Niger, the Senegal, or the Gambia, or in all three, and most of these have been recently found in Lake Chad and the rivers emptying into it. The collection made in Lake Chad by Captain Gosling, and sent by him to the British Museum, contains representatives of twenty-four species, all of which were previously known from both the Nile and the Niger, thus strikingly confirming conclusions arrived at from a study of the fauna of those two river-systems. Collections sent to the Paris Museum by the Chevalier and Decorse Mission, and worked out by Dr. Pellegrin, add twenty-five species to the above number, two described as new, two Nilotic, eight West African, five Congolese, the rest being common to the eastern and western river-systems. The Congo differs more considerably, and must therefore have been separated from the Nile-Chad-Niger for a longer period, only 15 out of its 265 species (excluding the Tanganyika) occurring also in the Nile, and eleven in the Chad. When we reach the district of the sources of the Congo, the so-called Katanga district, we find a mixture of Congo and Zambesi forms, which points to a former reversal of the drainage of parts of the elevated dividing range. Lake Mwero belongs to this district; although so near to Lake Tanganyika, it has no fish in common with it except a few of very wide distribution. Lake Bangweolo, also in the same district, is said to swarm with fishes, Silurids and Cichlids especially, but they have never been collected. The Zambesi, so far as it has been explored at present, is the poorest in fishes of the great rivers, and it differs from the others in one important point—the absence of the Polypteridæ. The great lakes differ considerably in their fishes from the river-systems into which they drain.

As pointed out eleven years ago by Prof. Gregory, the system of the head waters of the Nile must have been very differently arranged in times geologically quite recent. This is proved by what we know of the great lakes north of Tanganyika. Thus, of the species known from Lake Victoria, barely one-fourth occur also in the Nile, the rest being mostly endemic; whilst Lake Rudolf, which has now no communication with the Nile, has four-fifths of its species in common with that system. Lakes Albert and Albert Edward are very insufficiently explored and have only yielded a few species, one-half of which are Nilotic. Two fishes, Cyprinids, are all we know from Lake Baringo, one being a widely distributed Nile species, the other an East African. We must conclude from these data that Lake Victoria has long been isolated, whilst Lake Rudolf has until very recently been in communication with the Nile.

Lake Tsana, which is now the source of the Blue Nile, has recently yielded a large collection of fishes, showing a great variety of Cyprinids, either endemic or identical with species occurring in the eastern watershed, and closely allied to those of Palestine, but with no special Nile affinities. The discovery of a Loach (Nemachilus), the first known from Africa, points to an immigration from the Jordan, probably through the old Erythrean Valley. The only species which Lake Tsana has in common with the Nile (*Tilapia nilotica*) occurs also in the Hawash and in the Jordan.

From the vastly increased information we now possess of the fishes of the Nile-system, we are justified in believing in great changes in the hydrography of this part of Africa. The fishes of Lake Tsana would support Prof. Gregory's conclusion as to a communication with the Jordan through a river running along what is now the Red Sea, whilst those of the Lower Nile point to a direct communication between the latter and the Jordan, as advocated by Prof. Hull, migrations along two distinct channels having taken place at a time when the Mediterranean did not extend so far to the east as it does at present, and the Indian Ocean had not penetrated into the Erythrean Valley. A better knowledge of the fishes of Egypt has disposed of Prof. Gregory's arguments against a former communication between the Lower Nile and the Jordan.

The Nile in its widest sense, but without the great lakes, has 101 species, not including those that enter the sea: twenty-seven do not extend north of Khartoum, whilst only six are restricted to the river below the First Cataract. The most important additions made since Dr. Günther's account of them in "Petherick's Travels" are several Mormyrs, Barbus, and Synodontis, three Cichlids, a Xenomystus, a Nannæthiops, a Discognathus, a Barilius, a Chiloglanis, a Fundulus, an Eleotris, and the remarkable genera Physailia, Andersonia, and Cromeria, the latter the type of a new family.

Thanks to the collections made by Sir Harry Johnston and Col. Delmé Radcliffe, with the help of Mr. Doggett, and by M. Alluaud, supplementing those of Dr. Fischer, we may now draw up a list of twenty-five species from Lake Victoria. The comparative scarcity of animal and vegetable life in this great lake perhaps precludes expectation of a great increase in the number of species in the course of further exploration. Most of the species are endemic, and among the most remarkable types may be mentioned a Discognathus, a Mastacembelus (probably the

fish noticed by Grant as a Stickleback), and a peculiar genus of Cichlids, Astatoreochromis. No Polypterus has yet been found.

Lakes Albert and Albert Edward, recently visited by Mr. Moore, have furnished examples of nine species, mostly Nilotic in character, the most interesting being a Petrochromis, on account of its close affinity to a Tanganyika species.

Lake Rudolf, as stated above, differs hardly from the Upper Nile, only three of its sixteen species being indicative of immigration from the East. Not a single form is endemic.

The Senegal must have been very thoroughly explored by Dr. Steindachner thirty-five years ago, as a large collection made a few years since by the late M. Delhez has not resulted in a single addition to the list of species. The Gambia, on the other hand, is now much better known than it was, thanks to the two visits of the late Mr. Budgett, to whom we owe the discovery of two species. But it is the Niger which, through the collections made by Dr. C. Christy, the late Captain G. F. Abadie, Mr. Budgett, and especially Dr. Ansorge, has been productive of the most important additions to our knowledge. The most striking discoveries are the type of a new family, Phractolæmus, since re-discovered in the Ubanghi, and Polycentropsis, the first representative of the Nandidæ in Africa. Leaving aside species entering the sea, we now know fifty-four species from the Senegal, forty-one from the Gambia, and ninety-six from the Niger, the lower course of the latter being the most productive. A remarkable feature of these rivers is the comparative paucity of Cyprinids, and the total absence in the first two of the genus Barbus, which also appears to be absent from the Chad basin.

Our knowledge of the piscine inhabitants of the rivers flowing into the Atlantic between the mouths of the Gambia and of the Niger has also made considerable progress. The fishes of Liberia, collected by Dr. Büttikofer, have been described by Dr. Steindachner, and those of the Gold Coast, collected by the late Mr. R. B. Walker, have been reported upon by Dr. Günther. Sixty-seven species are on record from this district, twenty-four of them being endemic.

Further South, North Cameroon has yielded several additions, for a knowledge of which we are indebted to Dr. Lönnberg, whilst South Cameroon, together with the Gaboon district, has been diligently explored by Mr. G. L. Bates, with the result that a great number of new species have been brought to light. This part of Africa is specially interesting from the fact that its rivers interlock with the head waters of the Sanga, which belongs to the Congo basin, and, the fishes being mostly the same in both watersheds, in that district, a sort of passage is established between the Gaboon and Congo faunas. Among the most remarkable forms discovered by Mr. Bates we may mention the genera Microsynodontis, Allabenchelys, and Procatopus. Since Dr. Sauvage reported, twenty-five years ago, on the fishes of the Ogowé, a small collection has been made by the late Miss Kingsley, and described by Dr. Günther, and a number of new species have been characterised by Dr. Pellegrin. The number of species now known from this part of Africa amounts to eighty-seven for South Cameroon and the Gaboon, and fifty-four for the Ogowé. Very curiously, among them we miss Polypterus and Calamichthys, which occur in the Lower Niger and Old Calabar, and again in the Chiloango—a remarkable instance of discontinuous distribution, which cannot be accounted for by physical conditions, so far as we are acquainted with them.

The Congo system (exclusive of Lake Tanganyika), from which only about ninety species of fishes were known ten years ago, proves to be far richer than any other, for, incompletely explored as it still is, it has already furnished examples of 265 species, forty-five of which have been added since the publication of the work "Les Poissons du Bassin du Congo" in 1901. In fact, every collection made even in its most accessible parts adds new species to the list, and many of its rivers have never yet been fished for scientific purposes. No doubt we do not know more than two-thirds of the fishes of the Congo. The riches in Mormyrids, Characinids, Silurids, Cichlids, Mastacembelids, is something surprising, not only in the number of species, but also in their extraordinary variety of structure; and as many as seven species of Polypterids, out of the eleven that are now known, occur in this river-system. With the exception of the Cromeriidæ and Nandidæ, all the families known from the sub-region have representatives in the Congo.

Lake Tanganyika, now forming part of the same hydrographic system, has a somewhat different fauna, consisting mainly of Cichlids, to which we have specially alluded in an earlier part of this Address. But there are, in addition, a number of Silurids and Cyprinids, a few Mastacembelids and Characinids, a Cyprinodont, and a Polypterus. The latter belongs to a species otherwise restricted to the Congo, and of the four Characinids two are Congo and two are Nile forms. The total number of Tanganyikan species of fishes amounts to eighty-five, but, no doubt, many more await discovery. As I pointed out in reporting on Mr. Moore's second collection, I have reason to think that we do not know more than half the species of fishes inhabiting this extraordinary lake. The collection which has just been brought home by Mr. Cunnington will greatly add to our knowledge. I may here mention that Mormyrids, which were believed to be absent from Tanganyika, are therein represented by two species.

Lake Rukwa has recently been explored by Dr. Fülleborn, but the fishes, which have been referred to eleven species, belonging to widely distributed genera, have not been studied with a sufficient comparison-material: they appear to be mostly endemic forms.

Lake Mwero has representatives of fourteen species, five of which are endemic, the remainder being found also in the Congo or in the Zambesi, or in both.

The Zambesi, so far as we know it—and its upper parts have scarcely been explored—appears rather poor in fishes, only forty-one species having been recorded. All the genera are also represented in the Congo and in the Nile. Seven of the Zambesi species occur also in Lake Nyassa and the Upper Shiré, whilst in the present state of our knowledge twenty-seven species, mostly Cichlids, may be regarded as endemic to the lake and the Upper Shiré. It is perfectly clear, however, that Lake Nyassa differs far less from the Zambesi than Tanganyika does from the Nile or Congo; and, although the Cichlids are likewise represented by some remarkable genera, they cannot compare for variety with the other great lake the fauna of which has been such a surprise. Both the Zambesi and Lake Nyassa lack representatives of the Polypteridæ.

About forty-five years ago a collection of fishes was made in Lake Ngami, and twelve species were described in a very unsatisfactory manner by the late Count F. de Castelnau; unfortunately the types of these species are lost, and it is difficult to form an idea of their affinities. We know, however, that the lake, which is now rapidly drying up, was then inhabited by a Mormyr, a Clarias, a Characinid, and several Cichlids.

The rivers of Angola have been but imperfectly explored. They have yielded a number of Cyprinids and Cichlids, a few Silurids, Mormyrids, and Cyprinodontids, and the type of the remarkable genus Kneria, the second species of which inhabits East Africa.

III. THE EASTERN SUB-REGION.

As was mentioned in the beginning of this Address, latitude goes for little in the distribution of fish-life. This is proved by the very marked difference in general character of the fish-faunas of Abyssinia and Africa east of the great Rift Valley as compared to the Nile and Central and West Africa. No Polypterids or Mastacembelids, few Mormyrids, Characinids, and Cichlids, but a great number of Cyprinids, mostly Barbus, characterise this sub-region. Omitting catadromous forms, the list of fishes consists of one Lepidosirenid, six Mormyrids, eight Characinids, seventy Cyprinids, twenty Silurids, one Kneriid, six Cyprinodontids, and seven Cichlids.

Lake Tsana, with the upper affluents of the Blue Nile, differs very strikingly in its fishes from the Nile, with which it has only two species in common, a Silurid (*Bagrus docmac*), and a widely distributed Cichlid (*Tilapia nilotica*), which occurs also in the Hawash and in

Palestine. Nearly all the fishes are Cyprinids, mostly of the genus Barbus, which bear close affinity to Syrian types, as does also the recently discovered Loach (*Nemachilus abyssinicus*), so far the only known African representative of that Europæo-Asiatic group. The single species of the Cyprinid genus Varicorhinus is also suggestive of South-Western Asia, although a second African species inhabits Lake Tanganyika, and a third has lately been discovered in Morocco. Another Cyprinid genus, Discognathus, which is widely distributed over Southern Asia, from Syria and Aden to Burma, is represented by two species, whilst others are known from Abyssinia and East Africa (Gallaland, Kenya, and Kilimandjaro districts), and one each from the Nile and Lake Victoria. A remarkable negative feature is the absence, as in Syria, of Labeo, a genus abundantly represented in the Nile, Senegal, Niger, Congo, and Zambesi, and India, and more scantily in East and South Africa. It is a suggestive fact, tending to show that, somehow or other, Lake Tsana has only comparatively lately been in communication with the Nile, that the Varicorhinus and several of the Barbus are common to this lake and to some of the rivers of the eastern watershed; whilst not one of the Cyprinids occurs also in the Nile. The main stream of the Blue Nile has only been explored up to Rosaires, but the fishes obtained in that part of the river do not in any way differ from those of the Upper Nile.

The chief character of the rivers east of the Rift Valley is, as already stated, the number of species of Barbus. The Cyprinids are further represented by a few Labeo and Discognathus, by a Neobola, and by the only African representative of the Indo-Malay genus Rasbora. The Mormyrids are represented by six species only. The few Characinids belong to the genus Alestes and to its near allies Micralestes and Petersius. Of the twenty Silurids, some are widely distributed species, others are common to the Nile or to the Zambesi, whilst among the species with a restricted habitat we note a Physailia, two Bagrus, two Amphilius, a Synodontis, and two Chiloglanis—altogether a poor series as compared with other districts of Tropical Africa—and not a single autochthonous genus. A species of the remarkable genus Kneria, a few Cyprinodontids, and a few Cichlids of the genus Tilapia complete what is for a district of that extent, well watered and within the tropics, a very meagre list.

IV. THE SOUTHERN SUB-REGION.

Africa south of the Zambesi system has a poor fresh-water fish-fauna, but this is easily accounted for by the intermittent character of most of its rivers. The list I have drawn up from available data includes only fifty species, seven of which are partly marine. When discussing the distribution of the South African fresh-water fishes eight years ago Prof. Max Weber compiled a list of sixty-four species; but this included a number of truly marine forms, occurring only in estuaries, besides a few of very doubtful determination, which I am obliged to leave out. The majority of the exclusively fresh-water fishes are Cyprinids, viz. seventeen Barbus and three Labeo. Characinids are represented by the widely distributed *Hydrocyon lineatus*, which occurs in the Limpopo, and the newly discovered *Alestes natalensis*, from near Durban. Three Clarias, an Eutropius, a Gephyroglanis, and a Galeichthys, the latter semi-marine, represent the Silurids. The two Galaxias, as distinguished by Castelnau, the most remarkable type of the South African fish-fauna, and the two Anabas, are confined to the south-western district of Cape Colony. A Cyprinodontid of the genus Fundulus has been described from False Bay. Four Gobies and five Cichlids of the genera Hemichromis, Paratilapia, and Tilapia complete the list.

Poor as it is in fishes, the south-western district—the *Erica or Protea district* of Max Weber—derives a special character from the presence of the genera Galaxias and Anabas. The western district is also poor, and has only representatives of three families: Cyprinids, Silurids, and Cichlids; whilst the eastern district, from the Limpopo system and the tributaries of the Orange River to Natal, is the richest, two families, Characinids and Gobiids, being represented, in addition to the three above named. The recent discovery in the Vaal River of a Gephyroglanis, a Silurid genus otherwise known only from the Congo and Ogowé, deserves notice.

Whether the subterranean reservoirs of the Kalahari are inhabited by fishes, as is the case in the Northern Sahara, is still unknown.

Excepting such forms as are believed to have been directly derived from marine types, there is every reason to regard the piscine inhabitants of the fresh waters of South Africa as comparatively recent immigrants from the North.

V. MADAGASCAR.

It is extremely remarkable that this great island, which in most groups of animals shows so many striking features, should in its fish-fauna be one of the most insignificant districts in the whole world. For, if we exclude the numerous Grey Mullets and Gobies, and a few Perches of the genera Kuhlia and Ambassis, which live partly in the sea, and probably mostly breed in salt water, the truly fresh-water fish-fauna is reduced to sixteen species—viz., two Silurids, two Cyprinodontids, one Atherinid, four Cichlids, and seven Gobiids, the latter, no doubt, recent immigrants from the sea. The Silurids belong to two distinct genera, Læmonema, allied to the African Chrysichthys, first discovered in Mauritius, and Ancharius, allied to the marine or semi-marine Arius, and, perhaps, also entering the sea. Of the four Cichlids two belong to a very distinct autochthonous genus, Paretroplus, whilst the two others are respectively referred to the African genera Tilapia and Paratilapia. The two Cyprinodontids belong to the widely distributed genus Haplochilus.

In concluding this sketch, whilst looking back with satisfaction upon the rapid progress which African ichthyology has lately made, and expressing our gratitude to the Governments, institutions, and collectors to whom we owe this progress, we cannot abstain from pointing out how much remains to be done. All the great lakes are insufficiently explored, and Bangweolo has never been fished for scientific purposes, whilst within the limits of this colony an extensive collection from the Upper Zambesi is still a desideratum, and Lake Ngami is drying up without any of its fishes having been secured for study. The fishes of the Congo above Stanley Falls, and of many of its northern and all of its southern tributaries, are still unknown. But it is gratifying to observe the ever-growing interest in this hitherto somewhat neglected branch of zoology, and I may express the hope that the next decade will be productive of even greater results than have been achieved within the last.

NOTES.

WE regret to see the announcement of the death of Prof. Jules Oppert, professor of Assyrian philology and archæology at the Collège de France, renowned for his contributions to astronomical chronology and his works on Chaldea and Assyria.

THE Berlin correspondent of the *Times* announces the death, at seventy-six years of age, of Prof. Franz Reuleaux, who, as author of a number of engineering works and director of the Berlin Industrial Institute, rendered good service to the development of practical and scientific engineering in Germany.

NEW ORLEANS has been suffering from a serious outbreak of yellow fever, but there are now signs that the health authorities are getting the disease well in hand. Up to the end of last week, that is, a period of about four weeks, more than 1000 cases and 171 deaths had been recorded. It is believed that the fever was introduced into the city through fruit vessels arriving between June 1 and June 15 from Central America. All patients have been screened from mosquitoes, and there must now be little danger of infection from them.

THE returns of births and deaths recently issued by the Registrar-General, while in some respects satisfactory, in one are of a disquieting nature. This is with reference to

the birth-rate, which during the last few years has steadily been declining, and has now reached the lowest figure on record, viz. 27·0 per 1000 for London and 29·2 per 1000 for seventy-five large towns. There must come a time, if this decline continues, when the deaths will exceed the births, and our population will decrease—a serious catastrophe for the nation. Were it not for a diminishing death-rate, particularly among infants, this contingency would already have come to pass. It is especially among the middle and upper classes that the birth-rate has declined, partly owing to selfishness and love of pleasure, but also partly due to the strenuousness of the conditions of modern life.

SIR J. CRICHTON-BROWNE delivered his presidential address to the conference of the Sanitary Inspectors' Association on August 17. He dealt with the problem of the sanatorium treatment of consumption, and expressed the opinion that splendid results had been obtained by it, and that Dr. Maudsley at the British Medical Association meeting (see NATURE, August 3, p. 331) had spoken too despondently about it, which was to be regretted, as it might tend to check a movement of great promise. He proceeded to consider the question of physical deterioration, and then dealt at length with the housing problem, and pointed out the advantages from a health point of view of country life as compared with town life. That the townsman was shorter lived than the countryman was, he said, incontrovertible.

THE relief ship *Terra Nova* returned to Tromsö on August 10 with the members of the Ziegler North Polar Expedition on board. Mr. A. Fiala, the leader of the expedition, landed at Hull on Tuesday on his way to the United States, and gave a representative of Reuter's Agency an account of the experiences of the expedition. The *America*, with the members of the expedition on board, left Vardo on July 10, 1903. At the end of August the vessel reached Teplitz Bay, Crown Prince Rudolf Island, the most northerly harbour in Franz Josef Land, where magnetic and astronomical stations were erected. The ship was frozen in during October, and was wrecked by great ice pressure in the following month, so that the entire party had to be taken ashore on sledges. In January, 1904, during a gale, all the old ice in Teplitz Bay, with several miles of the glacier face, were broken and carried away, and with the bay ice disappeared all that was left of the *America*. Three attempts were made to reach the Pole by sledges, but the highest point attained was 82° 13′ north latitude. Mr. Fiala states that although the avowed purpose of the expedition—to reach the North Pole—was unsuccessful, the members have brought back data which should prove of scientific value, and have explored and surveyed the archipelago from Crown Prince Rudolf Land to Cape Flora, discovering four new channels and three large islands.

THE fifteenth International Congress of Americanists will be held at Quebec on September 10–15, 1906. The work of the congress will be concerned with the indigenous races of America, their origin, geographical distribution, history, physical characters, languages, civilisation, mythology, religion, manners, and customs; indigenous monuments and archæology of America; history of the discovery and European occupation of the New World. The president of the committee of organisation of the congress is Dr. Robert Bell, F.R.S., director of the Geological Survey of Canada, and the general secretary is Dr. N. E. Dionne, Quebec, Canada.

TRIALS of a system of signalling by bells under water, which has been developed by the Submarine Signalling Company, of Boston, U.S.A., were made by the Trinity House authorities on August 11. This invention, which was described in NATURE of April 20 (vol. lxxi. p. 595), has been used experimentally by the United States Lighthouse Board at several of their light stations during the past few years; it has also been adopted by the Canadian Government as an aid to navigation in the St. Lawrence. For the purpose of these trials the North Goodwin lightship was fitted with a submarine bell, and the Trinity steamship *Irene* with the necessary sound-receiving apparatus. At distances of from three to five miles the signals given by the bell were distinctly heard, and the direction whence they emanated could be readily noted.

MR. C. R. CROSBY has favoured us with a copy of a catalogue of the North American spiders of the group Erigoneæ, contributed by him to the *Proceedings of the Philadelphia Academy*.

THE fourth and final part of vol. xxv. of *Notes from the Leyden Museum* contains, among other papers, the concluding portion of the preliminary description, by Miss C. M. L. Popta, of new fishes collected in Borneo by Dr. Nieuwenhuis, and likewise one by Dr. Lidth de Jeudi on new Bornean lizards.

WE have received the report of the Trivandrum Museum and Public Gardens for 1903–4, which is signed by the new director, Major F. W. Dawson. In addition to statements in regard to the condition and progress of the establishment, some interesting details are given with regard to the amount of food consumed by some of the reptiles in the gardens; and Mr. Lydekker's paper, in the *Journal of the Bombay Natural History Society*, on certain dolphins recently taken on the Travancore coast is reproduced in full.

THE report of the Field Columbian Museum, Chicago, for the period 1903–4 contains reproductions from photographs of some of the chief objects of interest added during the year. The wide scope of the exhibits, and the beauty and thoroughness of the installation, are very noteworthy. Among the exhibits special reference may be made to one of a group of wild duck being stalked by a lynx, and to a second illustrating the ingredients entering into the composition of curry-powder. In the latter no less than thirty-one trays of distinct specimens are shown.

IN the course of last week's notes, reference was made (p. 385) to the web-making ants of the genus Œcophylla. In the latest issue (August 1) of *Biologisches Centralblatt* Dr. F. Doflein gives a detailed description of the habits of *Œ. smaragdina*, a species widely distributed in the Oriental region, accompanied by original sketches of the ants and their larvæ at work. When the edges of a leaf are to be joined, or when a rift appears in the nest, a small company of the workers place themselves in a line across the fissure, holding on to the one edge with their mandibles and to the other with their legs, which are stretched backwards to their furthest extent, and then with a united pull drag the two edges into contact. A second party then comes, and trims and fits the edges until they meet exactly, while finally comes a third party, each member of which carries a larva in its jaws. The larvæ, being put to work, immediately spin a "criss-cross" web by means of which the two edges of the leaf are firmly united.—In another paper in the same issue Mr. F. E. Zierler, of Dorpat, discusses the molar dentition of the fossil Suidæ in connection with their phylogeny. Apparently the author makes no reference to the theory that the crown-structure of the suilline molar is a degradation from the selenodont type.

AN interesting contribution to the history of the steam-engine is published in the *Engineer* of August 11 in the form of particulars of some old prints unearthed at the British Museum. One of the most interesting of these, engraved by Sutton Nicholls and bearing the date 1725, is that illustrated in the accompanying figure, reduced from one of the illustrations in our contemporary. The engraved part measures 13¾ inches by 12¾ inches, and on either side in letterpress appears a detailed description. The print is believed to be unique, and in point of date is second only in importance to the Dudley Castle steam-engine print of 1712, preserved in the Birmingham Free Library. It resembles the drawings of the Newcomen engine at the colliery at Griff, in Warwickshire, erected in 1722. Several changes in the mechanical details from the Dudley Castle engine may be noted. The boiler is fed with a portion of the hot water coming from the bottom of the cylinder, so that a date is fixed for this advance in economy. There are also two gauge-cocks instead of one, so that both high and low water would be indicated. Reproductions are also given in the same article of copper plates of the Newcomen engine erected at Passy, near

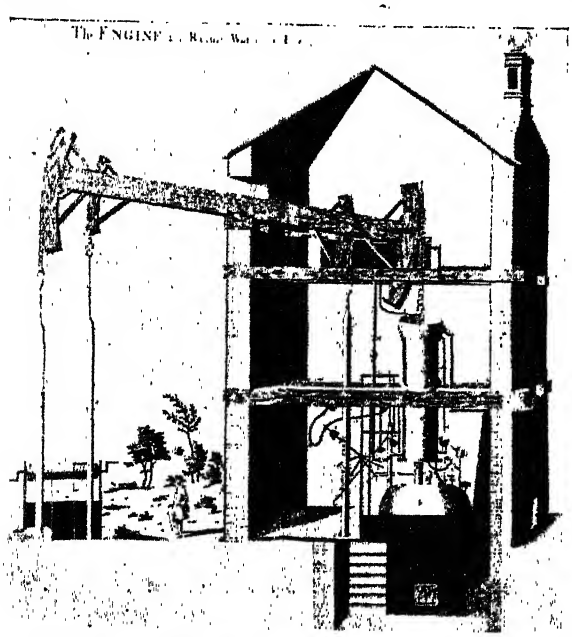

FIG. 1.—A mospheric Steam Engine, 1725 From the *Engineer*.

Paris, in 1726, which was copied from that at Griff Colliery. The first Newcomen engine on the Continent was, however, that put down in 1722 at Cassel by Joseph Emanuel Fischer von Erlach, who ordered at the same time in England a similar engine for draining a mine at Königsberg, in Hungary. This was completed in 1724 by one Isaac Potter from Durham, who was in consequence looked upon as the inventor.

THE *Journal of the Röntgen Society* for July (ii., No. 5) contains reports of meetings of the society and of the Röntgen Congress at Berlin, and various papers, notes, &c., as well as three plates of excellent radiograms and a portrait of the president, Mr. Wilson Noble.

THE *Journal of the Royal Sanitary Institute* for August (xxvi., No. 7) contains a valuable discussion on sanatoria for consumptives, opened by Mr. Edwin T. Hall, and an interesting paper by Dr. Rideal on the sterilisation of sewage effluents, with special reference to oysters and other shell-fish, and to watercress beds.

WE have received a copy of Messrs. Merck's annual report for 1904 on the advancements of pharmaceutical chemistry and therapeutics during that year. It contains a wealth of information, and should be in the hands of every medical practitioner and pharmaceutical chemist who wishes to keep abreast of modern work and progress.

THE Annual Report and Transactions of the Manchester Microscopical Society for 1904 has just reached us. The society is evidently in a flourishing condition, and several of the contributed papers are of interest, particularly those by Prof. Hickson, the president, on micro-organisms associated with disease, and by Mr. Gillanders on arboreal insects, with two illustrative plates.

WITH reference to a note on the Leishman-Donovan body or parasite which appeared in these columns (June 15, p. 157), Lieut. Christophers, I.M.S., writes pointing out that his researches on the development of flagellated forms antedated those of Leishman, but that Capt. Rogers, I.M.S., was the first discoverer of the metamorphosis. The latter fact was noted in NATURE (vol. lxx. p. 534).

PROF. F. RAMALEY contributes an account of the examination of certain foliaceous cotyledons to the *University of Colorado Studies* (vol. ii., part iv.). The anatomical structure of the cotyledons of several species of tropical plants was examined for comparison with the structure of the ordinary leaves.

A SIMPLE piece of apparatus, called a pinometer, for connecting both ends of a plant, cut as for a root-pressure experiment, has been devised and is described by Dr. O. V. Darbishire in the *Botanical Gazette* (May). The object of the pinometer, which is well adapted to ordinary class work, is to enable the experimentalist to study at one time both the suction force of transpiration and root-pressure. For research purposes the author is elaborating a more complex and precise form of the instrument.

SIR JOSEPH HOOKER continues his epitome of the British Indian species of Impatiens in No. 2, vol. iv., of the *Records of the Botanical Survey of India*. This includes a list of eastern Himalayan plants, of which the chief centre is Sikkim, and fifty species from Burma of which three-quarters are endemic. In addition to the new species which, as Sir Joseph Hooker expects, still await discovery in Sikkim and Burma, there is great need for collecting better material, more especially good specimens of the flowers and of separate parts of the flowers.

THE *Trinidad Bulletin* for July contains an account of the results obtained during the first year in manurial experiments with cacao plants on the Brasso Estate. Mr. E. H. Cunningham-Craig contributes some geological notes on soils in Trinidad to serve as an explanation of the geological maps that have been produced, and also to furnish a guide to cacao planters of the value and probable manurial requirements of the various soils. Mr. C. W. Meaden has an article on parasites in cattle and poultry, giving a detailed account of the parasite *Strongylus micrurus*, with remarks on the methods of treatment. A report on various rubber plantations in the island is presented by Mr. W. Leslie.

MESSRS. R. AND J. BECK, LTD., have sent us a dark screen mounted in a convenient way for use in viewing the eclipse of the sun on August 30. If the sky is clear, a smoked or very dark glass will enable the progress of the partial eclipse to be followed in any part of our islands.

OUR ASTRONOMICAL COLUMN.

OBSERVATION OF JUPITER'S SEVENTH SATELLITE.—A telegram from Prof. Pickering to the Kiel Centralstelle announces that Prof. Albrecht has observed Jupiter's seventh satellite with the Crossley reflector. Observations were made on August 7, 8, and 9, and on the first named day the satellite's position in reference to Jupiter was as follows:—

G.M.T.	Position angle	Dist.
1905 Aug. 7 96 ...	289°·7 ...	54'·6

(Circular No. 78 Kiel Centralstelle).

COSMIC DUST OF SOLAR ORIGIN.—The hypothesis that certain terrestrial phenomena, *e.g.* magnetic storms and auroræ, are caused by the earth passing through denser portions of streams of finely divided gravitating matter ejected by the sun is discussed by Prof. Schaeberle in No. 4041 of the *Astronomische Nachrichten*. One of the greatest objections to this hypothesis appears to be that no regularity of period has been discovered for the ejections which would fit in with the observed data of the terrestrial phenomena. Prof. Schaeberle shows, however, that a largely irregular period affords fundamental evidence in favour of the hypothesis.

Both theory and observation lead to the conclusion that the ejective forces on the sun are very variable, and this would certainly mean that the initial velocities of the particles ejected would vary considerably. In a table he has prepared the author shows that particles ejected with an initial velocity of 376·76 miles per second would just reach the earth's orbit, the time taken being 64·6 days. An initial velocity of 381·78 miles per second would carry the particles to four times the earth's distance; their velocity on passing the earth's orbit would be 22·4 miles per second, whilst the time taken to reach the earth on the outward journey would be 29·7 days; 1003 days would elapse before they crossed the earth's orbit on the return journey. Particles ejected with a velocity of 382 miles per second would cross the earth's orbit with a velocity of 25·9 miles per second in 27·4 days, and would be carried to an infinite distance. Thus a very small change in the initial velocity at which the particles are ejected causes a very large change in the time taken to reach the earth, and therefore Prof. Schaeberle maintains that the irregularity of such phenomena is evidence in favour of the existence of such streams. He also discusses some cometary phenomena which, he considers, furnish the strongest evidence in favour of the hypothesis.

THE ORBIT OF γ CORONÆ BOREALIS.—The following elements for the binary system of γ Coronæ Borealis have been deduced by Mr. Doberck, of the Hong Kong Observatory, from all the available observations recorded since 1826:—

$\Omega = 113^\circ\ 20'$	$\gamma = 80^\circ\ 8'$	$P = 79{\cdot}63$ years
$\lambda = 254^\circ\ 55'$	$e = 0{\cdot}3589$	$T = 1839{\cdot}60$
	$a = 0''{\cdot}598$	

Mr. Doberck gives a table containing the results obtained by each observer, omitting those which are in any way doubtful (*Astronomische Nachrichten*, No. 4041).

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 14.—M. Bouquet de la Grye in the chair.—The study of the solar atmosphere round the spots: H. **Deslandres.** The author explains in detail the method adopted by him for the study of the spectra of the sun-spots, the special lines selected being the K_1 and K_2 lines of calcium.—On the gases produced by actinium: A. **Debierne.** It has been shown by Ramsay and Soddy that solutions of radium salts give off detonating gas containing a very minute quantity of helium. The author has examined actinium salts from the same point of view, and has found that in this case also a mixture of hydrogen and oxygen is continuously evolved. Helium was found to be present in this gas, and in quantity comparable to that given by radium. By way of control, the experiments with a solution of radium bromide were repeated and the results of Ramsay and Soddy confirmed.—On the production of heavy liquids with the alkaline iodomercurates: M. **Duboin.** The compounds of mercuric iodide with potassium, sodium, lithium, and ammonium iodides have been prepared, and the densities of the heaviest solutions obtainable measured. Whilst Thoulet's liquid (solution of potassium iodomercurate) has a density of 3·196, the solution of the corresponding sodium salt has a density of 3·46, of lithium 3·28, and of ammonium 2·98. The sodium and lithium salts are therefore superior to the original solution proposed by Thoulet. They are soluble without decomposition in alcohol, and are suitable for the separation and determination of the density of minerals.—The pure culture of green plants in a confined atmosphere in presence of organic substances: M. **Molliard.** The results of the experiments show the possibility of the absorption and utilisation of glucose in sunlight by the plant, this absorption being increased when asparagine was also present in the solution.—The physiology of the placenta: MM. **Charrin** and **Goupil.**—On a toxic product extracted from the cerebral substance: A. **Marie.** The brain substance was brought into an emulsion with five times its weight of water, centrifugalised, and filtered, first through paper and finally through a Berkefeld filter. The liquid thus obtained showed distinctly toxic properties, the nervous system being especially affected.—On infectious anæmia in the horse: H. **Carré** and H. **Vallée.** Attention is directed to the state of latent infection exhibited by certain horses, apparently cured, and means given of detecting such cases. The results of the research are summarised in the form of practical instructions as to the best mode of dealing with an outbreak.—On the preparation of cholera toxin: MM. **Brau** and **Denier.**

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THURSDAY, AUGUST 31, 1905.

BRITISH MOSSES.

The British Moss-Flora. By R. Braithwaite, M.D., F.L.S., &c. Pp. x + 315; 268; 274 + plates. (London: L. Reeve and Co., 1887 to 1905.)

WE offer to Dr. Braithwaite our most sincere congratulations on the completion of this work on his favourite class of plants. Begun, as regards publication, in 1880, it reached completion by the issue of the last part with index and supplement in May of this year, so that the course of publication has occupied a space of some quarter of a century. In the last number Dr. Braithwaite takes leave of his readers in a postscript in which he expresses his regret that he is unable to include the Sphagnaceæ in the work; but he finds that to study these again at the age of eighty-one, and to draw some twenty-five plates, would be hopeless. All lovers of mosses will share in this regret, at the same time remembering that they owe to Dr. Braithwaite an interesting monograph on the peat mosses of Europe and America, published in 1880. The author concludes the whole matter with a quotation of some lines (little known, we suspect) by Ehrhart, which are interesting as disclosing the mental attitude of the venerable author at the conclusion of his labours; they begin thus:—

> "Vernimm's und siehe die Wunder der Werke,
> Die, die Natur dir aufgestellt!
> Verkündigt Weisheit und Ordnung und Stärke
> Dir nicht den Herren; den Herren der Welt?"

The three volumes of Dr. Braithwaite's book are illustrated by 128 pages of plates, giving figures of every moss described, with enlarged designs of parts of the various species. Every one of these plates has been engraved from the drawings of the author himself, and together constitute a remarkable monument of his skill and industry. Indeed, the illustrations may be regarded as perhaps the most distinctive feature of the work. In some cases a whole page is devoted to a single species, as Schistostega, or to two species, as in the strange genus Buxbaumia; but generally four or more plants are dealt with in a single plate. So far as we have compared the figures of our author with nature, we have found his drawings accurate, and the magnified parts very valuable for the purposes of identification.

If we were inclined to be adversely critical on the plates, we should say that to some extent strength has been sacrificed to elegance. If you turn from the drawings of Braithwaite to the plates of old Dillenius, you are conscious of a marked difference of treatment; the old figures are more robust and graphic, and the general facies of the plant is more forcibly impressed upon the mind. But this difference is perhaps an inevitable result of our advanced knowledge of the distinctions between kindred species; the earlier artist was not haunted by the perception of minute details which make the later artist at once more timorous and exact.

The classification principally adopted by Dr. Braithwaite is that of Prof. Lindberg, by which the cleistocarpous mosses are no longer treated as a group by themselves, but are introduced into the stegocarpous families, and are regarded as imperfectly developed forms of more highly organised stegocarpous congeners. There can be no doubt that the distinctions based upon the presence or absence of a peristome and on the number of teeth in the peristome received an exaggerated amount of attention from many bryologists; they were for the moss flora somewhat as the number of stamens and pistils was in the hands of Linnæus for phænogamous plants.

Whenever a genus contains more than one species, Dr. Braithwaite gives a clavis to the species, arranged dichotomously, and this appears to us to be very carefully and well done—a fact which increases our regret that the author has not given similar guidance between the families, subfamilies, and genera of the whole group, so that the student might have been conducted by the use of the necessary differentiæ from the summum genus to the ultima species. But where so much has been given, it would be ungracious to complain that something is still wanting.

Mr. Dixon, in his preface to his "Student's Handbook of British Mosses" (1896), referred to the book now under review as "Braithwaite's splendid and elaborate work . . . which has done so much to stimulate the study of these plants in our country and which will doubtless remain our standard work for many years to come." In this generous appreciation by one botanist of the work of another, we cordially agree, and we rejoice for ourselves, as well as for the author, at the completion of a noble piece of honest work.

Before we part from the book we wish to make this review the vehicle of a thought that has frequently occurred to us

In the last number of Dr. Braithwaite's book we find a notice of *Catharinia tenella*—which has been found near Goudhurst, in Kent, by that keen bryologist Lord Justice Stirling—mixed with *Catharinia angustata.* This is only one instance of a common fact, viz. the coexistence side by side of two kindred species.

Thus, turning over at random some pages of Wilson's "Bryologia Britannica" (a book more easy to use for such a purpose than the luxurious pages of Braithwaite), we find that *Fissidens viridulus* is recorded as growing with *F. exilis, Hypnum Swartzii* as growing with *H. praelongum, Hypnum chrysophyllum* as found with *H. stellatum, Hypnum resupinatum* in like manner with *H. cupressiforme,* and *Hypnum elegans* as often growing with *H. denticulatum*; and in all these cases the two species are so nearly akin that they stand next to one another on Wilson's pages. A further search would, we feel sure, bring to light many similar cases, including those in which forms recognised only as varieties are found side by side with the normal form. This fact seems to us to be worthy of further attention. Is it due solely to the suitability of the same spot to several species of the same genus, or is it

due to some genetic relation between the two organisms, the one producing the other at various times and in divers places in the same way as the normal *Linaria vulgaris* from time to time and in this spot and the other produces the peloric form? Have we caught one species in the act of producing another? E. F.

EXPERIMENTAL MORPHOLOGY.

Einleitung in der experimentelle Morphologie der Tiere. By Dr. Hans Przibram. Pp. 142. (Leipzig and Vienna: Franz Deulicke, 1904.) Price 4 marks.

THIS volume is divided into thirteen practically independent sections, and represents the "fast unveränderte Drucklegung" of a course of lectures delivered by the author during the session of 1903–4 at the Wiener University. The author has been induced to publish these lectures by the belief that all previous works of a general nature dealing with experimental embryology have either been written wholly in support of particular theories (*e.g.* Driesch, Haacke, Herbst) or only deal with a portion of the subject (*e.g.* Davenport, Hertwig, Korschelt, Maas, Morgan, Wilson, Ziegler). The present work is intended, therefore, as an introduction to the whole subject from an impartial standpoint.

In the first section, which deals mainly with the scope of experimental morphology, the author, after weighing the various names which have been proposed for the science—Entwicklungsmechanik, Entwicklungsphysiologie, kausala Morphologie, &c. —adopts Davenport's name, "experimental morphology," but defines it as including not only the experimental study of the factors determining form in ontogeny, but also in phylogeny (Umvandlungs-physiologie), so that Driesch's term "rationelle Morphologie" would seem to be more appropriate.

The uncertainty as to the proper scope of the science which this considerable choice of names exhibits is in part due to its recent growth, but it is also due in no small measure to the close connection in which experimental morphology must always stand to the other sciences.

That the author has not been more successful than his predecessors in determining suitable limits to the subject is very clearly shown by his treatment of the section dealing with the "Specifische Bestimmung." In this section the author describes the influence of relationship in transplantation experiments, and the persistence of specific characters in the transplanted tissues. He then refers to Heape's experiment, in which normal development of an Angora rabbit is obtained, though transplanted shortly after fertilisation into the uterus of a Belgian rabbit, from which, however, the author's conclusion that transfusion of strange blood has no morphogenic influence hardly follows. Following this is an account of immunity and blood relationship experiments. If it is difficult to see why these subjects should be included in a science ostensibly dealing with the factors determining form, this difficulty is still greater when the author proceeds to consider the distribution in the animal kingdom of the various proteid substances contained in muscle fibre.

In the fourth section, "Die Bewegung-Taxis," the author gives a series of very far-fetched comparisons between the behaviour of unicellular animals and of the higher Metazoa. The sensation of thirst is compared with the hydrotaxis of the Mycetozoa, and Davenport's example is followed in regarding as rheotaxis the behaviour of fish in swimming against the stream, the only position in which they are able to breathe. Finally, the "Thigmotaxis" exhibited by an oxytrocha moving round a spherical egg, unable to leave its surface, is compared with the retreat of a cat into the corner as a dog approaches, or to the preference shown by many people for those seats in a restaurant which have their backs to the wall!

In the twelfth section, "Die Vererbung," the author, after giving a brief account of the current theories of heredity, shows how these are in "schönster Uebereinstimmung" with our recent knowledge concerning the constitution of the nucleus. This agreement is obtained by assuming reduction to consist in the elimination of whole chromosomes during the maturation divisions, the view that this process represents the belated union of the paternal and maternal chromosomes not being mentioned.

In the final section, "Die Artwandlung," the author discusses the influence of external factors in causing transmissible variations.

The wide range covered by the book, the thirteen sections of which only average ten pages each, has resulted in a somewhat superficial mode of treatment, and neither in point of comprehensiveness nor of impartial treatment can the book be said to fill the want which, according to the author, has been left unsatisfied by all previous workers. G. C. C.

ATLAS OF EMISSION SPECTRA.

Atlas of Emission Spectra of most of the Elements. By Drs. Hagenback and Konen. English translation by Dr. A. S. King. Pp. v+70 and plates. (Jena: G. Fischer; London: Wm. Wesley and Sons, 1905.) Price 27s.

THIS atlas comprises the results of an investigation of the spark, arc, and flame spectra of most of the chemical elements. Twenty-eight charts are given showing heliographic reproductions of photographs taken with the aid of two small Rowland concave gratings, each of 1 metre radius and 20,000 lines to the inch. One of the gratings had a ruled space 9 cm. broad, and was used chiefly for the region of shorter wave-length. The other had a breadth of 5 cm., and was used to photograph the less refrangible portion of the spectrum. For each group of metals two charts are given, one showing the normally visual part of the spectrum, the other the violet and ultra-violet region. The dispersion given by the gratings is such that the length of spectrum from the K line of calcium (λ 3934) to the D lines of sodium (λ 5893) is about 4·5 inches, or 11 cm., each scale division on the reproductions corresponding to

ten tenth-metres. The region of spectrum studied extends from about λ 2500 to λ 7000.

In the production of the arc spectrum, rods of the metal were used as poles whenever possible, though in many cases carbon electrodes were employed, and scraps of metal or salts of the metal volatilised on them. The selection of carbon as electrodes seems to us a very unfortunate one, as it is next to impossible to disentangle the real spectrum of a substance from the structure of the carbon bands. Surely a better method would be to use poles of some inexpensive metal the spectrum of which is a fairly simple and characteristic one, such as zinc, aluminium, or silver.

Among the spectra represented in the charts are several, such as boron, arsenic, the rare earths, the platinum group, phosphorus, selenium, which are reproduced here for the first time. The previously existing records relating to some of these were very meagre, and those now published will be distinctly useful. For some of the gaseous elements vacuum-tube spectra have been obtained.

The authors have not given—and it seems unnecessary to do so—complete lists of wave-lengths, but have confined themselves to a selection of the most characteristic lines for each element. The wave-lengths of these are given only to the nearest Angström unit or tenth-metre, which is scarcely of sufficient precision for modern spectroscopic research. A chapter of notes is given at the end of the text, touching on such points as varying numbers of lines, kinds of spectra, character of lines, division into pairs, triplets, and series, lines specially prominent in any particular light source, &c.

Notable amongst the few elements not investigated by these observers is scandium. This is unique among the rarer metals in the prominence of its lines in various celestial spectra—notably the chromosphere and stellar types of intermediate temperature—and a reproduction of its complete spectrum would therefore have been of interest.

The reproductions are generally excellent; exception must be taken, however, to that of the solar spectrum, which, apparently included as a reference spectrum, is practically useless. Upon the whole, the production of the atlas is very creditable to the authors, and without being in some ways of so elaborate a nature as Crew's or the recently published atlas of Eder and Valenta, it will, through its uniform treatment of all the elements investigated, be useful, as the authors surmise, to the physicist, chemist, and astronomer.

F. E. B.

OUR BOOK SHELF.

Précis d'Hydraulique—La Houille Blanche. By Raymond Busquet. Pp. viii+375. (Paris: J. B. Baillière et Fils, 1905.) Price 5 francs.

THIS book forms one of a series of little volumes which are being issued under the title of "Encyclopédie Industrielle," and treats of the principles of hydraulics and their applications, which possess an enhanced importance in view of the recent great extension of the employment of water-power for industrial purposes, resulting from the discovery that it can be economically transmitted to a distance when converted into an electric current. Thus, by the development of electrical transmission, it is now practicable to use waterfalls and water stored up in reservoirs, in remote mountain valleys, as sources of power for towns, of which the Falls of Niagara, supplying electrical energy to Buffalo, furnish so notable an instance; and the author has given the name of "La Houille Blanche," or white coal, to this source of power.

The subject is discussed in five chapters, dealing successively with fundamental laws, flow of liquids in pipes, flow of liquids in open channels, hydraulic motors, and creation of a fall of water; and the text is illustrated by forty-nine diagrams and drawings. The hydraulic problems relating to the utilisation of water-power are solved by aid of arithmetic and simple geometry; and the author's aim has been, by making the book neither purely descriptive nor wholly didactic, to render it serviceable to a large number of persons. In the chapter on motors, the different forms of waterwheels and the various types of turbines are described; and, finally, the principle of the hydraulic ram is explained, as being distinct from motors, and yet transforming the fall of water into useful work by raising some of the water to a considerable height. Though reservoirs have been, and are being, formed by constructing high masonry dams across narrow gorges in the valleys of mountain streams, with the object of furnishing water-power, the final chapter of this book relates exclusively to the erection of a masonry weir across rivers, with the necessary sluiceway, closed by wooden panels, for the discharge of floods, by which the ordinary water-level of the river is raised so as to enable water to be drawn off into a branch canal for supplying water-power; and it deals mainly with the requisite calculations of the flow of the river, the discharge through the sluices, the pressure on the panels, the fall available, and the section of the branch canal and of its side retaining walls. The author entertains great expectations as to the future of water-power, and considers that, whereas last century was the century of steam, the twentieth century will be called the age of water-power, or white coal.

Catalogus Mammalium, tam viventium quam fossilium. By E. L. Trouessart. Suppl. part iv., Cetacea to Monotremata. (Berlin: Friedländer and Son, 1905.) Price 8*s*.

WE have much pleasure in congratulating the author on the completion of the first quinquennial supplement, whereby an absolutely invaluable work is brought well up to date, or, rather, as nearly up to date as is possible in undertakings of this nature. We notice that in the part before us references are given in the case of well-known species to passages in which they have been recently mentioned—a plan which cannot fail to be of the greatest assistance to students.

In accordance with the recent changes in nomenclature, the titles adopted for several genera differ from those employed in the original issue, as, for instance, Orcinus in place of Orca, on account of the preoccupation of the latter term. In the case of the Edentata, the list of names proposed by Dr. Ameghino for South American Tertiary forms looms very large, and, we fear, occupies much more space than it is really entitled to claim. In this connection it may be noted that the author follows Dr. Wortman in classing the North American Eocene ganodonts as ancestral types of the true edentates, Prof. W. D. Scott's recent opposition to this view probably not having been published in time to receive

notice. The classification of the ground-sloths is much more complicated than the one adopted by older writers, the Megalotheriidæ being now split up into a number of family groups. Very noteworthy is the inclusion among the Monotremata of an extinct South American family, the Dideilotheriidæ, with four generic modifications, as if this be justified it has a most important bearing on former land connections between the southern continents. We confess, however, to a certain amount of hesitation in accepting the determination of these South American fossils until it has been confirmed by a palæontologist of unquestioned authority. In retaining provisionally the South African Tritylodon among the mammalia, Dr. Trouessart is in accord with opinions lately expressed by Dr. R. Broom. R. L.

How to Know Wild Fruits: a Guide to Plants when not in Flower by Means of Fruit and Leaf. By Maude Gridley Peterson. Pp. xliii+340; illustrated. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) Price 6*s*. 6*d*. net.

"YE shall know them by their fruits" might well have served as the fore-word to this little volume. It deals only "with those plants which bear attractively coloured fruits," and might, therefore, be classed by the reviewer among that very large class of books which are made to look at rather than for any more serious purpose. The very first chapter, on "Adaptations of Fruits and Seeds for Dispersal and Protection," serves to dispel that notion. It consists only of some half-dozen pages, but those pages are instructive, and, better still, suggestive. Then comes a list of "definitions," few in number, but adequate to a book of these pretensions, especially as it is supplemented by a glossary at the end. "A Guide to the Plant Families Represented" comes next in order, and consists of an analytical table by means of which the several families may be discriminated by the observation of the variations in the character of their fruits. This seems to be carefully compiled, and is, so far as we have seen, accurate, but its value can only be tested by actual use in the field.

In the second table the families and species are grouped according to the colour of their fruits. Thus the monocotyledonous families are arranged according as the colour of the fruits is red, reddish-purple, green, black, or dark-purple, or blue. Of course, this is a highly artificial mode of grouping and one subject to exception, but if these circumstances be borne in mind the table will be found useful.

Coming now to the individual plants, which are all North American, the author gives a pretty full description of each, beginning with the fruit and passing on to the foliage and flowers. These descriptions might have been materially abridged and comparison rendered easier by the omission of unnecessary particles and verbs. In this matter the example of the author's fellow-countryman, Asa Gray, might have been followed. Moreover, they are not always botanically accurate; the "fruit" of the yew, for instance, is only remotely "drupe-like," and is certainly not a "drupe," as it is said to be in the same paragraph. Conversely, the leaves of the yew are really spirally arranged, but appear to be disposed in two planes only.

It would obviously be unfair to treat this book as if it were intended as a botanical text-book, but as a help to the beginner and a means of stimulating observation it may be commended. It is well got up, remarkably free from misprints, appropriately illustrated, and provided with an index of vernacular names and one of the Latin designations of the plants described.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Kangra Earthquake of April 4, 1905.

THERE have been certain papers on Indian geological questions recently published in the *Neues Jahrbuch* and associated *Centralblatt für Mineralogie, Geol. und Pal.* (Stuttgart), in which either the data or the deductions, generally both, have been unsound. In most cases the authorship alone has been sufficient to enable us to separate those papers that are worth careful study from those that are not even worth the time necessary to read. But in the latest production one of the editors of the journal appears as a joint-author, and one wonders consequently whether the papers we have been discarding in India as untrustworthy are, after all, normal or accessory constituents of a periodical which all geologists have regarded hitherto as essential to a working library.

The paper I now refer to appeared in the *Centralblatt* No. 11 (June), entitled "Das Erdbeben im Kangra-Tal (Himalaya) von 4 April 1905," by E. Koken and F. Noetling. The authors take eight pages of text and a map to demonstrate the unusual features of scientific interest shown by the recent earthquake—the time of its occurrence, the remarkable variation in the rate of transmission of the earthquake waves in different directions, the peculiar distribution of the isoseismal lines, and the exceptional shape of the meizoseismal area. The whole of this "scientific" discussion is built on a few newspaper cuttings, in the collection of which the authors have not been sufficiently industrious to escape certain tell-tale misprints which appeared only in the newspapers of the Presidency farthest removed from the earthquake centre. One example will be sufficient to illustrate the care exercised in collecting and checking their data.

The authors on p. 336 refer to a town named Tagarmalli as only very slightly damaged, and they consequently adopt this point, which they determine to be fifty miles from the epicentre, as the maximum extension eastwards of the meizoseismal area. As a matter of fact, no such place as Tagarmalli exists, and no such name appears in any of the gazetteers of India; the most casual attempt at verification would have shown the authors that they were basing their elaborate deductions on a misprint which appeared in one newspaper only. In one of the Lahore papers the names of the two places Nagar and Manali, twelve miles distant from one another in the Kulu valley, became contracted by the printer's devil to Nagarmalli, and in this form it was telegraphed to Bombay (*Times of India*, April 14) and to Calcutta (*Englishman*, April 14); but by the accidental omission of a single Morse's dot the word reached Madras as Tagarmalli (*Madras Mail*, April 15, and telegraphic summary, April 14). Having found the clue to the authors' source of data, we find it easy to explain other equally remarkable statements in the paper. In an earlier part of their paper (p. 334) they refer to the complete destruction of the place Nagar (Naggar), without suspecting that it was one of the roots of their mythical Tagarmalli; but on this occasion they have removed the little capital town of Kulu, and, for purposes of seismological reasoning, have carried it over the snowy range into the Kangra valley. To base a series of scientific deductions on a few newspaper cuttings may satisfy the devotee of precision (*alias* accuracy) in Germany, but to neglect the simple means of verifying their facts provided by the splendid maps of the Punjab, the complete gazetteers, or even the four-penny postal guide obtainable in nearly every village, shows a carelessness that deserves the contempt of every scientific man.

But, after all, it is not the basis of data so much that is at fault, though even the purchase of a few more newspapers would have saved the authors from most of their pitfalls; it is the "scientific" superstructure that is so discreditable. When the authors noticed that the earthquake was recorded by the Bombay seismograph at

5.45 a.m., although the shock started from the focus, 1280 kilometres away, at 6.10, they examined their data with due scientific caution, and so discovered that the local time-standard of Bombay accounted for the apparently negative result; but as they obtained from their newspaper a positive record for the Calcutta seismograph, the application of the same system of scientific criticism of the time-standards did not occur to them. As a consequence, they arrive at the astonishing result that, whilst the earthquake waves travelling southwards to Bombay had a speed of 4.266 kilometres a second, those which were transmitted south-eastwards had a speed of 0.700 kilometres only.

The rest of the paper consists of "facts" and "inferences" of this kind, and whilst most are unimportant, it is desirable, perhaps, to point out that the epicentre determined by the authors is far removed from the true one. They have had to stretch their epicentre for more than forty miles to the west to account for the "complete destruction" of Pathankot. I was at Pathankot soon after the earthquake, and found it difficult to discover even a masonry crack in the town; even a few more newspaper cuttings would have shown the authors that the place was practically undamaged.

After picking a few pebbles out of this conglomerate of truth and fiction, one wonders why the paper was ever published at all. The very newspaper from which they obtained their data must have informed the authors that a thorough investigation of the earthquake had been organised by the Geological Survey. As both authors were in Madras at the time, one would imagine that a subject sufficiently interesting for a serious paper in a leading scientific journal would be worth, at any rate, a few more newspaper cuttings, even if a personal visit to the affected area were thought to be, for private reasons, inconvenient. We take it for granted that the long experience of both authors must have brought them into contact with the etiquette observed by scientific men, and that neither would consciously risk the recognised danger of forestalling the results of a thorough investigation by the publication of conclusions obtained from unverified data. But whatever the object, if the editor of a leading scientific journal can join in the production of such a paper, the future of scientific literature in Germany may yet give us entertainments as surprising as any of the recent efforts of the Russian Navy.

Of the Kangra earthquake, as well as of the other Indian questions which have been treated recently in the *Centralblatt* with an equal regard for accuracy, those who wish to know the truth will be provided with details in due season. Within a few days after the disaster occurred, every telegraph operator, meteorological observer, and district official north of the latitude of Bombay was provided with a complete guide for reporting the resulting phenomena, and the reports so obtained have since been supplemented by a detailed examination of the affected area by five officers of the Geological Survey. The observations made will be summarised first in the next part of the records, and the full details will form a special memoir, now in course of preparation. When these reports are ready, it will be seen that the actual facts, though in ways interesting and novel, are scarcely so strange as German fiction.

T. H. HOLLAND.

Calcutta, July 20.

The Transverse Momentum of an Electron.

WHEN Newton's third law is applied to an electron, it makes

$$\mathbf{F} = \dot{\mathbf{M}} + \dot{\mathbf{N}}, \qquad (1)$$

where $\mathbf{M}$ is the "momentum" in the field, or that part of the time integral of the force on the ether which is in the field, or $\Sigma\, \mathrm{V}\mathbf{DB}$, and $\mathbf{N}$ is the momentum already wasted, whilst $\mathbf{F}$ is the applied force on the electron. Similarly, Newton's fourth law (or the Scholium to the third) makes

$$\mathbf{Fu} = \dot{\mathrm{U}} + \dot{\mathrm{T}} + \mathrm{W}, \qquad (2)$$

if $\mathbf{u}$ is the velocity of the electron, U the electric and T the magnetic field energy, and W the rate of waste of energy.

Now, both W and $\dot{\mathbf{N}}$ are known in terms of the velocity and acceleration of the charge at any moment by formulæ I gave in NATURE, October 30, November 6, 1902. But when applied to (1), (2), these equations do not let us determine $\mathbf{M}$ generally in terms of the velocity and acceleration, on account of the variability of the state of the field, and the waste of energy and momentum. $\mathbf{M}$ is indefinite. But in long-continued forced circular motion of a charge, $\dot{\mathrm{U}} + \dot{\mathrm{T}} = 0$. So

$$\mathbf{Fu} = \mathrm{W} = \mu \mathrm{Q}^2 a^2 / 6\pi v \kappa \qquad (3)$$

(*loc. cit.*), where Q is the charge, and a the acceleration (or u^2/R, if R is the radius of the orbit). Also, $\kappa^2 = 1 - u^2/v^2$. The direct or $\mathbf{u}$ component of $\mathbf{F}$ is therefore known. We also have (*loc. cit.*)

$$\dot{\mathbf{N}} = (\mathbf{u}/v^2)\mathrm{W}. \qquad (4)$$

Using this in (1), along with (3), we come to

$$\kappa^2 \mathbf{F}_1 = \dot{\mathbf{M}}_1, \qquad \mathbf{F}_2 = \dot{\mathbf{M}}_2, \qquad (5)$$

where $\mathbf{F}_1$ is the $\mathbf{u}$ component, and $\mathbf{F}_2$ the transverse component, towards the centre.

Thus only the part $\kappa^2 \mathbf{F}_1$ of the direct force is associated with the transverse or centripetal force $\mathbf{F}_2$ in keeping up the revolving state, the rest of $\mathbf{F}_1$, that is, $(u^2/v^2)\mathbf{F}_1$, being the wasted part as regards momentum, although the whole of $\mathbf{F}_1$ is concerned in the waste of energy.

Now, $\dot{\mathbf{M}} = \mathrm{V}\mathbf{nM}$, if $\mathbf{n}$ is the angular velocity. That is,

$$\dot{\mathbf{M}} = \dot{\mathrm{M}}_1 \mathbf{u}_1 + \mathrm{M}_1 \dot{\mathbf{u}}_1 + \dot{\mathrm{M}}_2 \mathbf{a}_1 + \mathrm{M}_2 \dot{\mathbf{a}}_2, \qquad (6)$$

if $\mathbf{u}_1$ and $\mathbf{a}_1$ are unit vectors, making

$$\dot{\mathbf{u}}_1 = (u/\mathrm{R})\mathbf{a}_1, \qquad \dot{\mathbf{a}}_1 = -(u/\mathrm{R})\mathbf{u}_1. \qquad (7)$$

Also $\dot{\mathrm{M}}_1 = 0$, $\dot{\mathrm{M}}_2 = 0$, because the motion is steady. So we convert (5) to

$$\kappa^2 \mathbf{F}_1 = \dot{\mathbf{M}}_1 = -\mathrm{M}_2 (u/\mathrm{R}) \mathbf{u}_1, \quad \mathbf{F}_2 = \dot{\mathbf{M}}_2 = \mathrm{M}_1 (u/\mathrm{R}) \mathbf{a}_1. \quad (8)$$

Finally, although we get no formula for M_1, we do obtain a complete formula for M_2, viz.,

$$\mathrm{M}_2 = -\ \mu \mathrm{Q}^2 a / 6\pi v \kappa^2. \qquad (9)$$

This is the transverse momentum of Q in steady circular motion, without any limitations upon the size of the velocity and acceleration, save the usual ones, $u < v$, and a not excessively great in regard to the diameter of the electron.

It would seem that an integration over the whole field, in which $\mathbf{E}$ and $\mathbf{H}$ are known (*loc. cit.*), is required to find $\mathbf{M}_1$, the direct momentum. If, however, the acceleration is infinitesimal, the known formula for M_1 in steady rectilinear motion may be employed, viz. $\frac{1}{2}\mathrm{M}_1 u = \mathrm{T}$.

Finally, I have pleasure in saying that Mr. G. F. C. Searle, F.R.S., led me to see that my waste formulæ led to the formula (9) for the transverse momentum, by submitting to me a calculation of M_2 in the special case of infinitesimal acceleration and velocity. He made no use of the waste formula, not being aware of it, but, since in the circumstances the waste is infinitesimal, it did not matter. In fact, $\frac{1}{2}\mathrm{M}_1 u = \mathrm{T}$ leads to the reduced special value of the transverse momentum when u and a are infinitesimal. The argument became somewhat obscure by the want of comprehensiveness, but the result agrees with (9).

OLIVER HEAVISIDE.

August 20.

A Parasite of the House-fly.

I SHOULD be very glad if Mr. Hill (p. 397) would send me a few specimens of the *Pseudoscorpiones* he has found attached to common house-flies, and I will endeavour to identify them for him. There are several genera of this order represented in the British fauna, and it is probable that all the species occasionally attach themselves to the legs or wings of larger insects and arachnids. There is some doubt, however, whether this is a case of true parasitism. It may be that the occasional association of these small arachnids with larger and more rapid arthropods is of importance to the species in providing a means for a wider geographical distribution.

SYDNEY J. HICKSON.

The University, Manchester, August 25.

THE TRANSPLANTATION OF SHELLFISH.

FOR the past three years an interesting series of experiments has been carried out on the Lancashire coast by the officials of the Lancashire and Western Sea Fisheries Joint Committee with the object of improving the condition of the public shell fisheries. It has for some time been felt that the introduction of restrictive legislation has not removed all the difficulties incident to the successful protection of cockle and mussel beds where the beds do not form part of a several fishery, that is to say, are under private ownership. Restrictive methods such as the abolition of destructive implements of fishing and the prevention of the removal of cockles and mussels under a certain size, no doubt do protect beds from excessive depletion, but there are various factors which require other treatment for their solution. In some districts, notably at Morecambe, beds have become overcrowded, so that thinning is an absolute necessity. In one instance the present writer counted 116 small mussels adhering to an area of one square inch. In other cases there is the danger that the molluscs may become smothered by sand, or that the "spat" has struck too near the high-water mark for the mussels to develop to the size at which they may legally be taken by the fishermen. Three years ago the scientific sub-committee of the Lancashire Sea Fisheries District expended a small sum of money in order to try the experiment of thinning the Morecambe mussel beds. The shellfish that were removed were transplanted to other suitable areas nearly or entirely bare of shellfish.

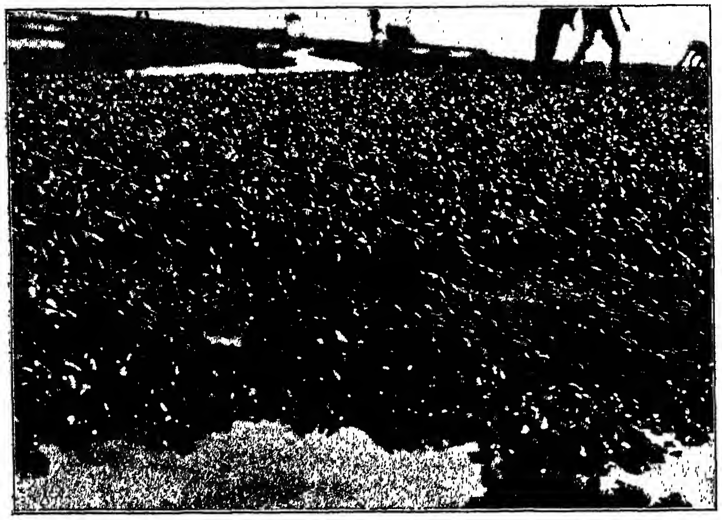

FIG. 1.—An overcrowded Morecambe mussel bed.

Samples of the mussels were taken before and at frequent intervals after transplantation. It was found that the experiment was successful, and in the following year (1904) the work was extended to other districts on the Lancashire coast, and attention was not only directed to mussels, but cockles were transplanted from overcrowded beds in the neighbourhood of Southport. This year the experiment has been proceeded with still further. Cockles have been transplanted successfully at Lytham and Southport, and mussels at Morecambe, Flookburgh, and in the Wyre and Lune estuaries. The work is carried out under the superintendence of the committee's bailiffs, and the shellfish gatherers are paid per tide for the work involved as well as for hire of boats. The mussels are generally removed at the commencement of the close season—which lasts in this district from April to August inclusive—so that the fish have a chance of accommodating themselves to their new environment without disturbance. Care is also taken to remove shellfish under the legal size so that their growth can be tested before they become "sizeable" fish for the market. The renewed growth which takes place in old cockles and mussels which had previous to removal not grown for years is remarkable.

The amount of shellfish transplanted is in the aggregate considerable, as may be seen from the following. In four days at Morecambe alone 152 tons 11 cwt. of mussels were re-deposited in localities favourable for their vigorous growth. At Lytham undersized cockles were removed from places where they were left dry too long by the receding tide, as a consequence of which their growth was checked, to more suitable ground where their growth was likely to be facilitated. This work is rendered possible by the Sea Fisheries (Shell Fish) Regulation Act of 1894, which *inter alia* provides that a local fisheries committee shall have power to stock or re-stock any public fishery for shellfish, and for that purpose to incur such expenses as may be sanctioned by the Board of Agriculture and Fisheries. The fishermen themselves, who may invariably be trusted to express their criticism of any work undertaken by the committee in a frank and outspoken manner, in this case express their appreciation of the efforts of the committee to improve and maintain the shellfish industry on the Lancashire coast. The value of the cockle industry to the Lancashire cocklers is approximately 20,000*l.* per annum.

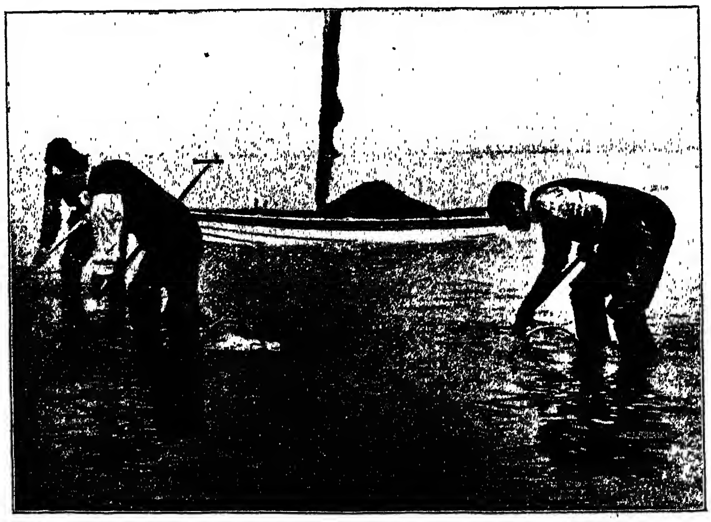

FIG. 2.—At work with the "Craam."

THE STANDARDISATION OF SCREWS.

THE question of standardising screw threads and limit gauges has long received the careful attention of engineers, and in Great Britain considerable advantage has accrued from the publication of an interim report (No. 20, April, 1905) of the Engineering Standards Committee, dealing with the form and pitches of screw-threads most suitable for general engineering purposes. Having regard to the fact that the Whitworth thread is in general use throughout the country, the committee does not recommend any departure from this form of thread. The existing Whitworth series of pitches for screws from ¼ inch to 6 inches in diameter does not, however, satisfy all requirements, and the committee has drawn up tables of standard sizes which will doubtless meet with general adoption. For all sizes of screw threads below ¼ inch in diameter the committee recommends the adoption of the pitches, sizes, and form of thread proposed by the British Association Small Screw Gauge Committee in 1884.

In France an influential committee of the Société d'Encouragement pour l'Industrie nationale, consisting of General Sebert and Messrs. Carpentier, Sauvage, Masson, Sartiaux, and Zetter, has devoted attention to the subject, and has published in the current issue of the Bulletin of the society a scheme for extending the international system to screws of less than 6 millimetres in diameter. The committee recommends the adoption, between the diameters of 1 millimetre and 5.5 millimetres inclusive, of twelve screws as shown in the following table:—

Diameter mm.	Pitch mm.	Diameter mm.	Pitch mm.
1·0, 1·25	0·25	3·0, 3·5	0·60
1·5, 1·75	0·35	4·0, 4·5	0·75
2·0, 2·5	0·45	5·0, 5·5	0·90

The six largest screws of this series are those first proposed by the second committee of the Chambre syndicale des Industries électriques. The screws of 2 millimetres and of 2.5 millimetres for which the pitch is 0.5 millimetre having proved too coarse, have received the pitch of 0.45 millimetre. The 1 millimetre screw has received the pitch of 0.25 millimetre in order to bring the new series into accord with the Thury series, which is used for very small screws. The scheme appears likely to be favourably received by the Swiss and German industries.

The initial accuracy of a helical surface, as distinct from the sectional form of the thread, is dependent upon the accuracy of the leading screw of the machine upon which it is cut, and thus the leading screw becomes a generating master-gauge which instead of being used solely for gauging is called upon to do work involving wear. The importance of maintaining the accuracy of these leading screws in connection with the production of the interchangeable parts of modern guns and gun mountings led to the appointment in November, 1900, of a committee consisting of Mr. H. F. Donaldson, chief superintendent of the Royal Ordnance Factories, president, Mr. R. Matthews, Lieutenant A. T. Dawson, R.N., Mr. H. J. Chaney, Dr. R. T. Glazebrook, F.R.S., and Colonel H. C. L. Holden, R.A., F.R.S., to consider the provision of standard leading screws for screw-cutting lathes, and its report to the secretary of the Army Council has just been published. The committee finds that the only practical way to obviate the difficulty found in securing absolute interchangeability, even on short lengths of large screws, is to provide centrally special machinery for the supply of large screws of certified accuracy. Approval of funds for this purpose was accordingly sought and obtained. The machine, which was made by Messrs. Armstrong, Whitworth and Co., of Manchester, was designed to secure accuracy over 3 feet length of screw. Measurements made after the machine was installed in the special chamber erected for it at the National Physical Laboratory showed that the movement of the tool carriage did not vary from that produced by a true screw of the same reputed length by more than 0.0002 inch in its full length, and after insertion of a correcting cam by more than 0.0001 inch at any one point, and that corrected microscopic scale readings and independent end-measure readings did not differ by more than 0.0001 inch at any point. The committee recommends that all accurate screws required for Government engineering work be supplied in future from screws originated from or corrected by the standard leading-screw adjusting machine at the National Physical Laboratory, and that facilities be given to private firms to correct heavy screws of ½-inch pitch by this machine. The house in which the machine is installed at the National Physical Laboratory presents many points of interest, as the greatest possible precautions have been taken to maintain uniformity of temperature and freedom from vibration.

THE STERILISATION OF WATER IN THE FIELD.

IT is well known that disease is more fatal to the soldier in a campaign than the bullets of the enemy. Thus in the South African campaign the total deaths from disease were almost exactly double those due to wounds in battle. The diseases which persistently dog the track of an army are typhoid or enteric fever, dysentery, and, in certain countries, cholera, and to these the principal mortality is due.

As regards their incidence, much necessarily depends on the climatic and physical conditions of the country in which the war is being carried on. Both in the Spanish-American war and in the South African war typhoid fever proved a terrible scourge.

These diseases are usually largely water-borne, but it must be recognised are not exclusively so, and, therefore, attention to the water supply alone will not wholly prevent them. In the Spanish-American war, for instance, the commission which investigated the typhoid fever epidemics of the United States Army reported that infected water was not an important factor in its spread. The other agents concerned in the dissemination of this disease are dust and flies, blowing or carrying infection from infected latrines, and gastro-intestinal disturbance, the result of heat, fatigue, and bad food rendering the troops more vulnerable. It cannot be doubted, however, that a pure water supply would do much to lessen the incidence of typhoid fever and dysentery, and probably quite prevent cholera.

A pure water supply can partially be secured by three methods; (1) by a careful selection of the camping grounds and protection of the water supply from pollution; (2) by deep-driven artesian wells; and (3) by the sterilisation of the water; or a combination of these methods may in many instances be adopted. But whatever method is applied it must be remembered that soldiers parched with thirst *will* drink any water that comes in their way. As regards the first method, the selection of the camping grounds, &c., it is reported that it has been adopted with considerable success by the Japanese in the present campaign; a corps of medical officers is sent on ahead to select the camping ground and survey the water supply;

sources which seem to be polluted can thus be largely excluded, and by judicious arrangement of the latrines and by posting guards to prevent individual pollution and the drinking of suspicious supplies much may be done to ensure pure water for drinking. As regards artesian wells, surface wells and streams are the main source of danger, but by driving deep artesian wells a pure water is obtained. This, however, would be possible only under special conditions in certain districts and for comparatively small contingents.

There remains the method of sterilisation, which, if it could be universally applied, would necessarily prevent water-borne disease.

The three methods applicable for the sterilisation of water are :—(1) filtration through a porous porcelain filter such as the Pasteur-Chamberland; (2) heat; and (3) chemical germicides.

Filtration through a porcelain filter, if it can be applied, would be efficient, but it necessitates a good deal of apparatus, and the filter candles are fragile. It is a good method under efficient supervision, but is more applicable for small contingents than a large army.

Heat has been adopted by many inventors, and Mr. Arnold-Forster, M.P., recently inspected a number of devices based on this principle. In most, *e.g.* the Lawrence, Forbes, Mallock, and Tuckfield and Garland machines, the water is heated to the boiling point, but in the Griffiths machine it is assumed (from experimental evidence) that heating to about 170° F. suffices, which results in a considerable economy in fuel. In all the machines the out-going hot water warms the in-going cold water, and is itself cooled thereby. Important considerations are weight and fuel, and these have received much attention from the respective inventors.

The Mallock machine, which, including pump and cases, weighed 153 lb., with a consumption of one pint of kerosine gave 50 gallons of water an hour at a temperature of 88° or 90°, the temperature of the in-going water being 74°. The Tuckfield and Garland machine, of which the steriliser weighed 198 lb. and the heating apparatus 126½ lb., gave 40 to 50 gallons at a temperature of between 104° and 110°, the temperature of the in-going water being 78°; its inventors state that it requires 20 lb. or 30 lb. of kerosine for 1000 gallons of water, and in it the water to be sterilised is heated by steam generated in a separate boiler. The Griffiths machine, weighing 120 lb. and using 1½ pint of kerosine an hour, yielded 26½ gallons of water an hour at a temperature of 92°, 45 gallons an hour at a temperature of 103° to 106°, and 72 gallons an hour at a temperature of 105°, the temperature of the supply being in all cases 67°. The Lawrence apparatus, weighing, with water-tank and case, 168 lb., and working with supply water at 74°, had a temperature of delivery of 88° to 90°, but it used two pints of kerosine an hour and the quantity of water delivered was only 30 gallons an hour. Finally, the Forbes machine, weighing 130 lb., delivered 15 gallons of water an hour, with an oil consumption of one pint, the temperature of supply being 74°, and of delivery from 86° to 90°.

Lastly, there remain the chemical germicides. Obviously these must have no deleterious action on man in the quantities employed; they should not be corrosive to metal vessels, they should be portable and act rapidly. Alum has long been employed for purifying water, but its action is to *clarify* a turbid water, and it cannot be relied on to *sterilise*. Potassium permanganate may be used, but is not very efficient or trustworthy, and both it and alum necessitate the water being left for some hours. Some three or four years ago Parkes and Rideal introduced bisulphate of soda for the purpose. It may be put up in tablets, and in quantities of 15 grains to the pint or thereabouts destroys the typhoid bacillus in water within half an hour, imparts little or no taste to the water, and is quite harmless. Lastly, there is the method introduced lately by Lieut. Nesfield, I.M.S., in which chlorine is the sterilising agent, and this, after acting, is "killed" by the addition of sulphite of soda. For small quantities of water, iodine may be similarly used. This last method was recently described in NATURE (July 27, p. 307), and has much to commend it.

R. T. HEWLETT.

PROF. JULES OPPERT.

On August 21 died Prof. Jules Oppert, the last of the band of great scholars who were the pioneers of cuneiform decipherment. His name will go down to posterity with those of Rawlinson, Hincks, de Saulcy, and Fox Talbot, with whom he helped to lay the foundations of the flourishing science of Assyriology. Like them, too, he has now laid down the pen for ever.

Born of Jewish parents in Hamburg on July 9, 1825, Jules Oppert began the study of Sanskrit and Arabic under Lassen and Freytag at Bonn, afterwards devoting himself to Zend and Old Persian at Berlin and Kiel. In 1847 he published his first work, entiled "Das Lautsystem des Altpersischen," in which he discovered that *m* and *n* had to be supplied before a following consonant in Old Persian, and thereby supplementing the alphabet. At that time the German law did not permit Jews to hold professorial posts, so in the same year he moved to France, where he was appointed professor of German at Laval, and afterwards, in 1850, at Rheims. The favourable reception accorded to his work on the Achæmenian inscriptions obtained for him, in 1851, a post on the staff of the scientific mission dispatched to Mesopotamia by the French Government, under MM. Fresnel and Thomas.

On his return in 1854, Oppert devoted himself entirely to the study of Assyrian and Babylonian, and between 1857 and 1863 the several volumes of his great work "Expédition scientifique en Mésopotamie" saw the light. While the linguistic value of this has always been of the greatest importance, the topography is less fortunate, the late author having been led into the mistake that the ruins of ancient Babylon were much larger than they really are. In 1855 he visited the British Museum and the museums of Germany to report on the progress made in cuneiform studies, and on his return in the following year he was decorated with the Cross of the Legion of Honour, and obtained the post of professor of Sanskrit and comparative philology at the school of languages attached to the Imperial Library at Paris. Two years previously he had become a naturalised Frenchman. In 1859 he published a Sanskrit grammar, closely followed by "Éléments de la Grammaire assyrienne." In 1865 there appeared from his pen a short history of Babylonia and Assyria. In 1881 he succeeded the late M. Mariette as a member of the Institute of France, being elected president of the same society ten years later—perhaps the highest honour a French *savant* can receive.

The versatility of the late Prof. Oppert was extraordinary. His papers, published in various scientific journals, cover an astonishing range of subjects. Not the least interesting are his contributions to astronomical chronology, in which subject he took a deep interest. In "La Chronologie biblique fixée par les Éclipses des Inscriptions cunéiforme" (*Rev. Archeol.*, 1868) he attempted to reconcile the dates

of the Old Testament with those of the Assyrian monuments. Other astronomical works are:—"Die astronomischen Angaben der assyrischen Keilinschriften" (Band xci., *Kais. Akad. der Wissensch.*, 1885), "Un Annuaire astronomique babylonien utilisé par Ptolémée (*Journ. As.*, 1890), "Les Éclipses mentionnées dans les Textes cunéiformes" (*Zeitschr. für Assyr.*, 1897), and many others of less importance. One of his last works was a contribution to chronology, entiled "L'Année de Meton" (*Rev. des Études grecques*, 1903). In his early days he had been a great champion of the genuineness of cuneiform decipherment, when its opponents counted among their ranks such great men as Renan and many others. He was one of the historic four who, at the invitation of the sceptics, produced a translation of the cylinder of Tiglath-Pileser I., which was read at a meeting of the Royal Asiatic Society by the president, and found to be substantially the same as the translations of Rawlinson, Hincks, and Fox Talbot, all of whom had bound themselves over not to collaborate or communicate with one another.

NOTES.

AT the time of going to press, no message had been received from Sir Norman Lockyer as to the eclipse observations at Palma. The following telegram from the Astronomer Royal had, however, reached the Royal Society:—"Eclipse satisfactorily observed, but partially cloudy. Photographs with all instruments."

PROF. RONALD ROSS informs us that the announcement to the effect that he has proceeded to New Orleans with Prof. Rubert Boyce, in connection with the outbreak of yellow fever there, is without foundation.

THE sixteenth annual general meeting of the Institution of Mining Engineers will be held at Manchester on September 13–16. The following papers will be read, or taken as read:—Leading features of the Lancashire coalfield extended: J. Dickinson; up-to-date electrical power distribution: R. L. Gamlen; can explosions in coal-mines, with their associated toxic fatalities, be prevented? B. H. Thwaite; earth in collieries, with special reference to the recently issued departmental rules: S. F. Walker; the value of mollusca in Coal-measure stratigraphy: J. T. Stobbs.

THE Local Government Board has issued a circular to borough councils and other local authorities respecting cerebro-spinal or "spotted" fever. This disease has recently been somewhat prevalent in Central Europe and in America, but the Board expresses the opinion that there has been no increase of the disease in England. For the guidance of local authorities the chief features of the disease are detailed, and, should an outbreak occur, the Board is prepared to advise the authority respecting it and to sanction notification.

DURING the past week the weather over the British Islands has been very unsettled; on Thursday last, heavy rain set in over many parts of Ireland, and continued almost without interruption for about thirty-four hours. The amounts measured during this period were 4·17 inches at Greystones, 4·33 inches at Dublin, 4·71 inches at Dundrum, and 5·09 inches at Bray, causing disastrous floods in various parts of that country. At Little Bray, the inmates of the lower-lying houses had to be rescued by boats. Sharp thunderstorms occurred in London and other parts on Sunday, Monday, and Tuesday, causing much damage to property. At Leigh, in the neighbourhood of Tonbridge, the trunk of an oak tree was torn in half, and a man who was seeking shelter under it was killed. During this period, rainfall has been considerable in all parts of the British Islands; in the twenty-four hours ending at 8h. a.m. on Tuesday, August 29, the amounts at Oxford and Yarmouth exceeded an inch, and an inch and a half was measured in the neighbourhood of London.

THE programme of the Iron and Steel Institute for the meeting to be held at Sheffield on September 26–29 includes the following list of papers:—Wear of steel rails on bridges: T. Andrews, F.R.S.; metallurgical department of Sheffield University: Prof. J. O. Arnold; thermal transformation of carbon steels: Prof. J. O. Arnold and A. McWilliam; nature of troostite: Dr. Carl Benedicks; occurrence of copper, cobalt, and nickel in American pig-irons: Prof. E. D. Campbell; transformations of nickel steels: L. Dumas; on steel for motor-car construction, and on vanadium steels: L. Guillet; presence of greenish-coloured markings in the fractured surface of test pieces: Captain H. G. Howorth; over-heated steel: A. W. Richards and J. E. Stead, F.R.S.; segregation in steel ingots: B. Talbot; manipulator for steel bars: D. Upton; influence of carbon on nickel and iron: G. B. Waterhouse.

ATTENTION is directed by the *Engineering and Mining Journal* of New York to a new development in mining which has not been generally noticed, namely, the working of alluvial tin deposits by dredging in the same manner as that followed in the case of gold-bearing gravel. In New South Wales the dredging for tin ore has become an established practice. In 1904 there were seven dredges in operation, which obtained 319 tons of tin ore, valued at 26,000*l*. The successful development of this practice in New South Wales suggests that it might possibly be applied with advantage in the Straits Settlements and elsewhere.

IN a paper read before the Geological Society of America, Mr. George P. Merrill described a large block of massive serpentine traversed by veins of so-called asbestos from Thetford, Canada, now exhibited at the United States National Museum at Washington. Incidentally discussing the origin of the veins, he suggested that the vein cavities are shrinkage cracks filled by a process of crystallisation extending inward from either wall, and compared the veins to the shrinkage cracks formed in septarian nodules of clay ironstone, and their filling with fibrous material to the crystallisation of fibrous gypsum in limestone.

AN ordinance relating to lead works has just been issued by the German Imperial Chancellor. The employment of women and lads in dust chambers and flues and in the transport of the dust is prohibited. The workmen employed at the furnaces may not work more than eight hours a day. The same rule applies to the workmen working inside cold furnaces or engaged in cleaning dust chambers and flues containing wet dust. Workmen engaged in cleaning dust chambers and flues containing dry dust are not permitted to work more than four hours a day inside such chambers and flues, and not more than eight hours a day in all. Food must not be taken to the working places. Working-suits, respirators, and gloves must be worn. Smoking cigars and cigarettes during work is forbidden. The rules will come into force on January 1, 1906.

THE most important paper in the June issue of the *Proceedings of the Philadelphia Academy* is perhaps one

by Mr. J. A. G. Rehn on the brown grasshoppers (Acridiidæ) of Costa Rica, in the course of which a number of new species are described. The collections examined included nearly three hundred specimens.

It may be remembered that the remains of James Smithson, the founder of the Smithsonian Institution, who died in 1829 and was buried in the English cemetery on the heights of San Benigno, Italy, were removed to Washington last year and formally handed over to the Regents of the institution. The body, upon its arrival in Washington in January, 1904, was placed temporarily in a room in the Smithsonian building containing the relics of Smithson. While resting there, the remains were examined by medical experts and found to be in a remarkable state of preservation. Meanwhile a small mortuary chapel was prepared for them on the immediate left of the north entrance of the Smithsonian building, and on March 6, 1905, the remains were brought to this chapel and, in the presence of the Regents, replaced in the original tomb,

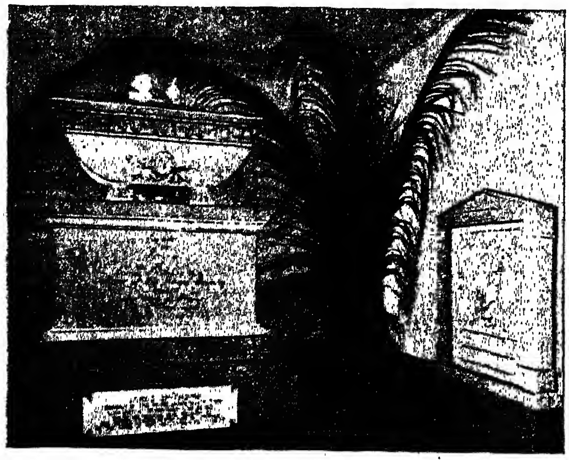

FIG. 1.—Interior of Smithson Mortuary Chapel, Smithsonian Institution.

shown in the illustration, which has been reproduced from the *Smithsonian Quarterly* (vol. xlviii.), where they will rest until Congress makes adequate provision for their fitting interment.

IN *La Nature* of July 29 Prof. E. T. Hamy, the well known professor of anthropology at Paris, gives an account, illustrated by reproductions from photographs of the animal shortly after death, of a gigantic gorilla recently shot on the Sangha River, Congoland. It is said to have measured no less than 2 metres 30 cm. (7 feet 6¾ inches), and the height of the carcase in a sitting posture reached, as shown in the photograph, to the waist of a full-grown native. Prof. Hamy believes the specimen to indicate a new race, if not a new species, of gorilla.

FROM the report on the museums of the Brooklyn Institute of Arts and Sciences for 1904 we learn that special attention is being devoted to improving the installation of the children's museum. As first arranged, this part of the exhibition series was found to overlap in a considerable degree the ordinary collection, and steps were accordingly taken to do away with this duplication. Elimination, both from the museum and the illustrative lectures, of material not likely to interest children has also been undertaken, with the result that the collection has been entirely re-modelled, and is now as suitable for its present purpose as it can be made.

THE chief feature of the July issue of the *Emu* is formed by the plates, one of which gives a full-sized figure, from a photograph, of the New Calendonian kagu (*Rhinochaetus jubatus*), to which allusion has been made previously in these columns; while others (also from photographs) are devoted to the illustration of the parasitic habits of Australian cuckoos, which appear to be very similar to those of our own species. Of these three plates, one represents a young bronze-cuckoo (Chalcococcyx) ousting a blue wren (Malurus) from its rightful nest, the second a young fan-tailed cuckoo (Cacomantis) in a brown tit's (Acanthiza) nest, while the third shows a young bronze-cuckoo in the nest of a brown tit.

IN the *Zoologist* for August the editor commences a series of articles on the factors conducive to extermination of species, dealing in this instance with natural as distinguished from human agencies. Unfortunately the article is marred by several serious mistakes. We are told, for instance, that "the opossum" is the only non-Australian mammal, the cuscuses of Celebes and Cœnolestes of Brazil being ignored; while in the same sentence we are informed that monotremes are confined to New Zealand! Again, we are unaware what ground there is for the statement that fossil marsupials are known from Asia. Minor errors, such as nummulitids for nummulites, are also noticeable. In the same issue is a very interesting article by Mr. H. H. Patterson on the heronry at Reedham, Norfolk. In the case of a note on the occurrence of the lesser horse-shoe bat in Shropshire, the editor might have pointed out that Noctilio is not the generic title for these bats.

THE fourth volume of "The Museums Journal" (Dulau and Co.), edited by Mr. E. Howarth, covers the period from July 1, 1904, until June 30 of the present year, and contains the report of the council submitted at the Norwich Conference of 1904. Although now somewhat ancient history, that report records continued progress on the part of the association, both as regards membership and funds for permanent investment. It is also satisfactory to learn that the journal itself is becoming more and more widely appreciated, and consequently shows a constant tendency to increase in bulk. The museums directory, or list of the museums in the United Kingdom, is likewise proving larger than was anticipated, the volume just received continuing the list from London to Stalybridge inclusive, together with supplements. One of the difficulties which the editors experience is in getting local curators to send in the names and objects of the institutions under their charge. The attendance of delegates from foreign museums at the last two conferences is another satisfactory feature in connection with the progress of the association. Among features connected with progress in regard to museum work, attention may be directed to the adoption by the Museum of the Federated Malay States of the card-system for the registration of specimens.

MUCH interesting information with regard to animals in menageries and the evolution of museums on the other side of the Atlantic is conveyed in a pleasant style in the course of an illustrated article by Mr. E. S. Hallock published in the August number of the *Century Illustrated Monthly Magazine*. "The menagerie," writes the author, "developed along with the circus, but differed from the latter in being an animal-show pure and simple. . . . Some menageries were stationary, while others travelled from place to place in large vans." The "dime-

exhibition" and the "curiosity-house" were devoted more to the exhibition of rare and interesting animals, monstrosities, &c., and from these, by the elimination of the "freak" element, are derived the modern American scientific museums. Reference is made to the camel exhibited in London in 1650, the Indian rhinoceros (described by Dr. Parsons) in 1685, and to Wombwell's unrecognised gorilla. Less well known is the case of the first great ant-eater exhibited in the London "Zoo," which was purchased about 1850 from two sailors, by whom it had been brought from Rio, for 300*l.*; and also that of a full-grown mandrill captured on board a slaver, and exhibited in Bristol in 1828, and later on in London. The most interesting record in the article is, however, the reference to a pair of South African giraffes imported into America in 1836, the same year in which the London gardens received their first representatives (of the northern race) of the species. In stating that the London establishment received its first representative of the southern form in 1895 the author makes a pardonable error, the fact being that the true southern race never has, so far as we know, been exhibited alive in this country.

THE most generally interesting feature in the report of the Indian Museum, Calcutta, for 1903–4 is the reference to a suggestion made by the director of the natural history branch of the British Museum that all the Indian type specimens might be transferred to the institution under his charge. The suggestion—which Major Alcock refers to in his section of the report as "most reasonable"—was largely based on the fact that the climate of Calcutta renders "types" as objects of reference almost useless, and that the interests of science would accordingly be advanced by their transference to the chief natural history centre of the British Empire. By the terms of their trust the trustees found themselves, however, unable to hand over the "types" formerly belonging to the Asiatic Society of Bengal, while they were disinclined to accede to the request as regards other "types" for fear of handicapping workers in India. Commenting upon this decision and its consequences, Major Alcock directs the attention of the Government of India to the administration of the museum, stating that the zoological staff is altogether inadequate. "An imperial museum of natural history," he writes, "such as the zoological section of the Indian Museum was designed to be, should be at once a complete and modern index of the fauna of the country, an object lesson in the more important general principles of zoology, an unfailing magazine of well-preserved material for research and distribution, and a centre where natural science is advanced by the discovery and publication of new facts. The facts that the Museum receives a grant for teaching-preparations from the local Government, and has decided that its 'types' must be kept on the spot for reference, indicate that this is the standard the Trustees wish realised. But grants of money and the possession of historic 'types' are not enough; equally essential are well-qualified paid assistants and reliable machinery for collecting new material and replenishing old."

A VERY interesting paper is contributed on the magic origin of Moorish designs to the *Journal of the Anthropological Institute* (July–December, 1904) by Dr. Westermarck. The magic consists entirely in the methods employed to ward off the evil eye, the fear of which is so potent in countries bordering the Mediterranean. The designs consist of hands, crosses, eyes, rosettes, squares, octagons, triangles, and innumerable conventional embroidery patterns; but they are all grouped round one central idea, the intention being to throw back the evil influence emanating from the eye, by some counter-charm. This is usually done by stretching out the five fingers of the right hand, and Dr. Westermarck shows how all these various designs can be traced to some elaboration of fives, originally representing the five fingers, or of eyes, for if baneful energy can be transferred by the eye, it can obviously also be thrown back by the eye. Sixty-two illustrations of these counter-charms accompany the article.

IN the course of a note on the supply of water to leaves on a dead branch, printed as part ii. of vol. xi. of the *Scientific Proceedings of the Royal Dublin Society*, Prof. H. H. Dixon adduces evidence, based on experiment, to show that when a portion of a stem is killed by heat, the cells give off poisonous or plasmolysing substances; for some such reason it appears that leaves attached to a dead branch wither much more rapidly than leaves on a living twig. In the first part of the same volume Mr. J. Adams discusses the effect of very low temperatures on moist seeds.

MR. D. HOOPER has a historical and explanatory note on the ancient eastern medicine known as lycium or rusot in the *Journal of the Asiatic Society of Bengal* (vol. lxxiii., part ii., No. 4). The identity of rusot with the Indian lycium of the ancients was first pointed out by Dr. J. F. Royle, who found out that it is an inspissated extract prepared from the wood and roots of several species of Berberis. Mr. Hooper's analyses of four specimens indicate an amount of berberine varying from 3 per cent. to nearly 8 per cent. The dried stem of *Berberis aristata* is officinal in India, and a tincture is often recommended in the treatment of fever.

IN the island of St. Vincent the Imperial Department of Agriculture for the West Indies controls an agricultural school and a land settlement scheme in addition to the botanic gardens. In the report for 1904–5 Mr. W. N. Sands, the agricultural superintendent, registers a distribution of nearly 30,000 plants, of which more than two-thirds were cacao, and, besides, smaller numbers of sisal bulblets, coffee, lime, and other economic plants. Many of these were distributed to allottees on the land settlement estates who cultivate cacao, canes, cassava, yams, and sweet potatoes. Mr. Sands, reviewing the progress of the cotton industry, has the satisfaction of recording that much of the sea-island cotton was the best produced under the auspices of the British Cotton Growing Association, and had realised seventeen pence per pound.

MR. W. E. COOKE, Government astronomer for Western Australia, has sent us a communication explaining a novel plan that he has adopted for giving more definiteness to the weather forecasts issued in that colony. Each forecast for a definite district is subdivided into specific items, to each of which a figure is attached, "1" representing that the occurrence prognosticated has only the barest possibility of being successful, and so on, up to "5," which indicates that the prediction may be relied upon with almost absolute certainty. Each item of the forecast has therefore a "weight" attached to it; on the whole, Mr. Cooke states that the new method has proved a distinct success, and that while people find that whenever the figure 5 appears the forecast is fulfilled in 99 cases out of 100, they do not feel so disappointed in case of failure when the lower numbers are attached, or as when, under the usual method, equal weight is attached to the whole forecast.

We have received the report of the Falmouth Observatory for the year 1904, reprinted from the seventy-second annual report of the Royal Cornwall Polytechnic Society. This observatory has for many years done excellent work in connection with meteorology and magnetism, as well as by the collection of sea-temperature observations at various places off the coast of Falmouth. The station has for many years been adopted by the Meteorological Office as one of its first-class observatories, and hourly observations or means have been regularly published in the official reports of that office. With regard to magnetism, the Falmouth Observatory has become additionally important, in consequence of the recording magnets at Kew and Greenwich being somewhat affected by the electric trams in those neighbourhoods.

Dr. Alberto Aggazzotti, writing in the *Atti dei Lincei*, xiv., (1), 12, describes some experiments conducted in the physiological laboratory at Turin on the effects of rarefaction on the respiration of the orang-utan. The animal on which the observations were made was brought from Borneo by Count Mario Peracca, who handed it over to Prof. Angelo Mosso for the investigation. It is described as being of good disposition and intelligent; at first it resisted the attempts to place it in the receiver, and tried to destroy the apparatus, but when it realised what was being done, it not only offered no further resistance, but even helped the experimenter in attaching the pneumograph and other necessary apparatus to it. A moderate rarefaction produced no injurious effects provided that the restoration of normal pressure was not effected too rapidly; at 450 millimetres of pressure the animal became more tranquil, at 300 millimetres it fell asleep, while at 270 millimetres it became seriously ill and fell down insensible. The respiration altered in character between 450 millimetres and 470 millimetres with an increase of frequency and a decrease of intensity, while at 300 millimetres it became irregular and spasmodic. These changes fairly well agree with those observed in other animals, particularly man.

Mr. C. Mosley has arranged an edition of White's "Selborne" for students, in which the whole of the letters are classified under subjects, giving the reader all that Gilbert White wrote on one topic under one head. As the subjects will be arranged alphabetically, the work will be one of reference as well as for reading consecutively. Mr. Elliot Stock is to publish the book during the coming season.

We have received a copy of the first fasciculus of vol. xxxv. of the *Mémoires de la Société de Physique et d'Histoire naturelle de Genève*. This part of the transactions contains, with other interesting papers, the president's report for 1904. Dr. Auguste Wartmann-Perrot successively passes in review the administrative events of the year, refers in eulogistic terms to the work of eminent members of the society deceased during the previous year, and recapitulates briefly the scientific subjects discussed in the meetings of the society during 1904. The biographical notices contained in the president's report include those of Charles Soret, renowned for his work in crystallography; of Albert Rilliet, the chemist; and of Wilhelm His, the anatomist. The scientific activity of the society is summarised concisely under subjects, and this part of the report will serve men of science as a full index of the work done by members of the Geneva Society during 1904. The president's statement is a useful account of a good year's work.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in September:—

Sept. 4.		Ceres in opposition to the Sun (Ceres mag. 7·4).
,, ,,	7h. 33m. to 8h. 37m.	Moon occults γ Libræ (mag. 4·1).
,, 8.	10h. 20m.	Minimum of Algol (β Persei).
,, 11.	12h.	Moon in conjunction with Saturn (Saturn 1° 56′ S.).
,, 14.	12h. 42m. to 14h. 11m.	Transit of Jupiter's Sat. III. (Ganymede).
,, 14.	23h.	Mercury at greatest elongation, 17° 54′ W.
,, 15.		Venus. Illuminated portion of disc = 0·787, of Mars = 0·851.
,, 17.	10h. 35m. to 11h. 36m.	Moon occults μ Ceti (mag. 4·4).
,, 18.	9h. 54m. to 10h. 55m.	Moon occults f Tauri (mag. 4·3).
,, 19.	10h. 36m. to 10h. 59m.	Moon occults γ Tauri (mag. 3·9).
,, 19.	13h. 56m. to 14h. 37m.	Moon occults 71 Tauri (mag. 4·6).
,, 19.	15h. 13m. to 16h. 36m.	Moon occults θ^1 Tauri (mag. 3·9).
,, 19.	15h. 18m. to 16h. 31m.	Moon occults θ^2 Tauri (mag. 3·6).
,, 19.	20h. 24m. to 21h. 1m.	Moon occults α Tauri (mag. 1·1).
,, 20.	14h.	Ceres 9′ N. of 89 Aquarii (mag. 4·9).
,, 21.		Saturn. Major axis of ring = 43″·30, Minor axis = 8″·36.
,, 19.	14h.	Moon in conjunction with Jupiter (Jupiter 4° 16′ N.).
,, 28.	12h. 3m.	Minimum of Algol (β Persei).

Observations of Planets.—The results of a number of recent observations of Saturn and Jupiter are recorded by Mr. Denning in the *Observatory* for August. Using the 12½-inch Calver reflector, some excellent observations of Saturn were obtained during the morning twilight in June and July. The region north of the multiple belt in the northern hemisphere was seen to be the brightest part of the planet—not the equatorial zone, as previously. A small white spot was detected on the N. edge of the great belt on July 6, and estimated to be central at 13h. 40m. A small white spot was seen in the N. temperate zone on the following dates in the positions and at the times stated:—

	Transit time h. m.	Long. System II. °
July 13	13 20	72·7
,, 16	15 35	67·3
,, 21	12 35	69·5

Observing the Great Red Spot on Jupiter on June 24 and July 6, Mr. Denning found it to be central at 15h. 43m. and 15h. 40m. respectively, the corresponding longitudes being 25°·1 and 24°·8. Comparing these longitudes with those published in the April *Observatory*, it is seen that during the period that Jupiter has been too near to the sun to be observable, the motion has conformed precisely with system ii. of the ephemerides based on a rotation period of 9h. 55m. 40·63s. An observation made by the Rev. T. E. R. Phillips confirms the above observation of July 6.

Proper Motions of the Hyades.—A discussion of the proper motions of the Hyades group is the *raison d'être* of No. 14 of the Publications of the Astronomical Laboratory at Groningen. The plates from which the proper motions were derived were obtained by Prof. Donner at Helsingfors and discussed by Profs. Kapteyn and W. de Sitter.

In the introduction to the volume Prof. Kapteyn gives a most interesting discussion of the results obtained by his method of determining proper motions, the method employed in the present case, in which a plate is exposed on a certain area and then packed away for a number of years, exposed again on the same area, and then developed and measured. One of the gravest objections to this method was the fear that the plates would deteriorate during the interval between the two exposures, but Prof. Kapteyn disposes of this objection by stating that not a

single plate of the present series, for which the interval was between four and five years, has had to be rejected. These plates were by Schleussner, on plate glass, and the method of preservation employed by Prof. Donner is explained.

As regards the length of exposure, Prof. Kapteyn states that, whilst it must be chosen in accordance with the particular work contemplated, it must be such as to give at least one hundred easily measured stars on each plate. Another objection raised against this method was that of accuracy as compared with the older method, but from a comparison of the probable errors now obtained with those obtained at Paris and Potsdam in the *carte du ciel* work, Prof. Kapteyn shows that the advantage is with the new method. He further concludes that to attain a given degree of accuracy the labour involved in the present method is *at the very least* seven times smaller than it would be by employing the older method.

The value for the proper motion of the Hyades group adopted by Prof. Donner is

$$\left.\begin{array}{l}\text{In R.A.} +0''{\cdot}0900 = +0{\cdot}00624\text{s.} \\ \text{,, Decl.} -0''{\cdot}0250\end{array}\right\}$$

Reduced to the system given in Publication No. 9, this becomes

$$\begin{array}{l}\text{In R.A.} +0''{\cdot}1107 = +0{\cdot}00767\text{s.} \\ \text{,, Decl.} -0''{\cdot}0259\end{array}$$

which is equivalent to a total proper motion of

$$0''{\cdot}1137 \text{ in position angle } 103^{\circ}{\cdot}17.$$

The general catalogue contains 395 stars, and of these 42 are considered as very probably belonging to the group, 19 are given as "probable," and 16 are regarded as "doubtful."

VARIATIONS OF LATITUDE.—In Nos. 4040–4041 of the *Astronomische Nachrichten* Mr. Kimura, of the International Latitude Observatory at Mizusawa, gives the results of a series of latitude observations made by Mr. Nakano and himself during the year March 28, 1903, to March 31, 1904. Simultaneous observations of four groups were made each night, their principal aims being (1) to examine whether there exists any regular diurnal change of latitude of a measurable quantity; (2) to see how large are the systematic differences between the variation of latitude from this (four groups) series of observations and that from the two groups observations for the international service. The mean declinations and proper motions of the stars observed were taken from the international service work, and the value of the "aberration constant" employed was 20″·512. Great care was taken during the reductions to eliminate accidental errors, and it was found that the personal equation between the two observers was practically negligible. The measures and their reductions are given in detail, and lead to the conclusion that "Any systematic diurnal change of latitude of a measurable quantity cannot exist at all." The subsequent comparison of the results of these observations with those obtained for the international service shows that no systematic differences exist between the four groups observations and the two groups observations made for the international service.

A PROPOSED NEW METHOD FOR DETERMINING THE SOLAR RADIATION.—In No. 4037 of the *Astronomische Nachrichten* Prof. Ceraski proposes a new method whereby the absorption of our atmosphere might be eliminated from observations of the changes in the solar radiation. His proposition is that the light of the telescopic planets should be regularly observed photometrically. If the variation of the solar radiation is great enough, it should be shown in the amount of light reflected by the planets, and a long period of photometric observations of these, such as he proposes, would show the sympathetic variations, whilst, if suitable comparison stars were employed, the differential effect of the earth's atmosphere would not affect the results.

THE CAPE OBSERVATORY.—The opening paragraphs of Sir David Gill's report for the year 1904 deeply lament the loss sustained by the Cape Observatory, and science in general, by the death of Mr. Frank McClean, F.R.S., to whose generosity the observatory owes an important part of its equipment.

The new transit circle has been thoroughly examined and its observers trained during the past twelve months, and it is now ready for routine work. It was found that by using the Repsold-Struve apparatus, in which a travelling wire actuated by clockwork is employed, the magnitude equation in right ascension observations might be almost, if not entirely, eliminated.

Preliminary trials of the new sidereal clock showed that the daily rate never varied more than ±0·03s.; but even this is to be improved by a new arrangement by which the top and bottom of the pendulum will be kept at the same temperature. In order to preserve a more equable temperature inside the case, an enclosing chamber 8 feet square and 13 feet high has been erected about it.

Owing to an unfortunate accident, the driving worm and sector of the Victoria telescope were damaged, and have had to be sent to Sir Howard Grubb for repair. In consequence, the new objective prism has not yet been tested.

A number of observations were made with the transit and equatorial instruments during the year, and 185 plates (containing 117,073 stars) for the Astrographic Catalogue were measured. The total number of plates measured is now 760, containing more than 440,000 star images, corresponding to about 200,000 different stars.

In the astrophysical department 74 star-spectra were photographed, and of these 30 have been measured, and a number of radial velocities deduced.

RECENT ADVANCES IN THE CHEMISTRY OF ALBUMIN.[1]

UNTIL recently, one of the main objects in studying the proteids was to classify them into characteristic groups by the aid of certain reactions. This has now given place to problems of a different nature—the investigation of the quantitative decomposition of the albumin molecule, the progressive degradation and study of the constituent parts, and the determination of the nature of what may be termed the stones of the molecular edifice; finally, the arrangement of these materials in the construction of the albumin molecule.

The task of separating the constituents of the albumin molecule is still far from complete. The reason for this lies in the difficulty connected with their isolation, for they are particularly troublesome to purify. An important advance was made when Emil Fischer discovered the ester method of separating the amino-acids by distilling them in a vacuum. The method bore immediate fruit in the discovery of phenyl-alanine and α-proline (pyrrolidinecarboxylic acid). Fischer has shown, moreover, that certain amino-acids, like alanine, phenyl-alanine, and serine (hydroxyaminopropionic acid) are invariable constituents of the albumin molecule, whilst hydroxy-α-proline, discovered by Fischer, is another widely distributed constituent. Ehrlich has found that the leucine from albumin, long considered a simple substance, is a mixture of at least two bodies. Hopkins and Cole have succeeded in separating tryptophane in a pure state, a substance which had long eluded the attempts of physiologists to isolate, and which they have pronounced to be skatolaminoacetic acid. Skraup has obtained from casein a whole series of new products belonging to the group of diamino- and hydroxyamino-acids—diaminoglutaric acid, diaminoadipic acid, hydroxyaminosebacic acid, and caseanic and caseinic acids of unknown structure.

New substances are constantly being added to the list of what may be termed molecular fragments, which now amount to about twenty individuals.

There still remains the carbohydrate group of albumins. F. Müller has shown that glucosamine from mucine and egg-albumin forms an interesting link between the sugar group and the amino-acids. We are still ignorant of the part played by the carbohydrate in its connection with albumin. We cannot say whether it is a loose combination or a mechanical admixture.

The enormous number of products gives some indication of the complexity of the problem which the study

[1] Abstract of an article by Emil Abderhalden contributed to "Medizinische Klinik," 1905, Nos. 1 and 2.

of albumin affords. Furthermore, before a synthesis can be successfully attempted, it is necessary to know whether these substances are primary or secondary products formed directly or indirectly by the action of the reagent, and here again the field is still untraversed.

Whilst great similarity exists among the constituent parts of the molecule, there is a wide difference in the proportions of each present. The *protamines*, which are obtained from the milt (testicles) of fishes, and represent some of the simplest proteids, contain a large proportion of diamino-acids and a small quantity of monoamino-acids; the kindred *histones*, on the other hand, contain a much smaller proportion of diamino-acids, but the whole group of monoamino-acids. Through a series of gradations we arrive finally at substances like the proteids of silk and elastin, which are exceptionally rich in monoamino-acids.

A comparison of the composition of the individual albumins of food and of the living body leads to the conclusion that in digestion deep-seated changes must occur. Moreover, the view is steadily growing that the albumin molecule forms the basis of the two other important groups of food-stuffs, fats and carbohydrates. The decomposition which certain albumin fragments undergo promises to throw new light on the changes which occur in the organism and on the formation of pathological products.

Granted that the whole series of albumin products were known, their relative arrangement in the molecule would still remain to be discovered. Attempts have been made by using milder reagents to arrest the process of degradation at an earlier stage, and so obtain larger molecular fragments; but great practical difficulties attend the method. Nevertheless, by the labours of Fischer and Bergell a series of no less than four intermediate products between silk and its lowest degradation product have been isolated. First, sericoine; secondly, a substance containing tyrosine; thirdly, one free from tyrosine; and lastly, a compound which probably belongs to the dipeptides mentioned below. This study of partial degradation of the albumin molecule derives increased interest from the behaviour of food albumin in the intestine, which, as Fischer and Abderhalden have shown by their experiments on dogs, probably undergo neither slight nor yet complete decomposition, but partial hydrolysis. It will be an attractive problem to determine how far food albumin may be degraded and yet afford nutriment for the organism.

If the process of decomposition cannot furnish the necessary information about the structure of the albumin molecule, the reverse process of synthesis may effect the desired object. E. Fischer has with wonderful experimental ingenuity and skill successfully followed this path of research. The classical memoirs on the polypeptides have already been referred to in the pages of NATURE. By combining two molecules of amino-acids, the dipeptides, glycyl-glycine, alanyl-alanine, and leucyl-leucine have been obtained, as well as mixed dipeptides, *e.g.* glycyl-alanine, alanyl-glycine, &c. By uniting three and more molecules, tri- and tetra-peptides, &c., are formed. The longest chain of this character is pentaglycine, consisting of a group of five linked glycine molecules.

But, as we have seen, the degradation products of albumin are not all monoamino-acids, but include hydroxy- and diamino-compounds, and peptides of these substances have also been prepared. These products show an unmistakable likeness to the natural peptones. They give the usual reactions—the biuret reaction, precipitation by phosphotungstic acid, and hydrolysis by trypsin. A peculiar interest centres round the different behaviour of the peptides towards the pancreatic ferment. Whereas glycyl-*l*-tyrosine and glycyl-*l*-leucine are easily hydrolysed, glycyl-glycine and glycyl-alanine are unattacked by the ferment.

These experiments, as Fischer has pointed out, are not only useful in indicating the physiologically important compounds among the numerous synthetic materials obtained by him, but show, by the experience so gained, the possibility of discovering the different kinds of linking which exist among the amino-acids of the albumin molecule.

We may anticipate from these investigations some knowledge of the cause whereby different parts of the molecule resist or retard the action of the ferment. J. B. C.

ON THE ORIGIN OF EOLITHS.[1]

FOR some time past the question of the existence of man in different countries during the Tertiary period, based upon flints bearing traces of intentional work, has occupied the lively attention of "prehistorians" in numerous parts of the globe—in France, England, Germany, Russia, Egypt, India, &c.

According to the eminent Belgian geologist, M. Rutot, who has placed himself at the head of this new movement, we must add to the Palæolithic and Neolithic periods a period more ancient still, which has received the name of *Eolithic*. This does not comprise any type of instrument chipped into an *intentional form*, but only natural forms utilised at once. These primitive and rough tools have received the name of *eoliths*. It is believed that they may be recognised by the presence of secondary work (*retouches*), that is to say, the removal of small flakes in apparently a systematic manner, in accordance with the needs of the case, or resulting from the wear of the flint by use.

An enormous quantity of eoliths are found in the Quaternary gravels mixed with instruments of determinate and classic forms. In the gravels of the north of France and of Belgium, M. Rutot has described several industries of this kind, the *Reutelian*, the *Mafflian*, the *Mesvinian*, &c. But such objects are equally met with in beds of far greater antiquity; the chipped stones of the Oligocene of Thenay, of the Miocene of Otta and Aurillac, of the Pliocene of England, &c., are eoliths; and here the question becomes far more grave, inasmuch as the adepts in the new theories rely on these facts to admit the existence of man or his immediate precursor during the Tertiary period.

For twenty years I have not ceased to combat these theories; first, because it appeared to me to be imprudent to admit the existence of Tertiary man in the absence of all direct, that is to say, in the absence of osteological evidence, and secondly, because I have always been convinced that the eoliths are due to natural causes. I had, indeed, had occasion to meet with them in all the ancient alluvia of torrential character in which flints were present. In Auvergne, and in the Velay, in the course of my explorations in connection with the geological map, I had found them at numerous points in the midst of Oligocene or Miocene beds occupying thousands of square kilometres in extent. I asked myself how experiments could be undertaken to solve the problem of the eoliths, when M. Laville, of the École des Mines, brought before M. Cartailhac, correspondent of the institute, Dr. Obermaier, and myself some experiments carried on daily, but unintentionally, in an industrial establishment.

There are in the Commune of Guerville, near Mantes, some works in which cement is made from a mixture of chalk and plastic clay. The chalk, as usual, contains blocks of flint which are rejected by the diggers. Trucks convey the chalk from the quarry to the neighbouring works, and deliver it with a certain quantity of clay into circular vats called *délayeurs*. These are about 5 metres in diameter and 1·40 metres in depth. The water which serves them arrives by pipes, and is discharged through lateral sieves, carrying with it the finest particles of the mixture of chalk and clay. The water is set in motion by a horizontal wheel, above the level of the water, but from its spokes are suspended harrows (*herses*) of cast-iron dipping into the water; the speed of rotation of the wheel is about 4 metres at its circumference.

The water is thus driven into a tumultuous movement, which carries away not only the particles of chalk and clay, but also a certain number of flints which have escaped the attention of the workmen, and have been thrown into the vats together with the chalk. These flints are therefore subjected to blows one against the other which during a period of twenty-nine hours must be extremely numerous. When the machinery is stopped, the flints remain at the bottom of the vat, where they are covered by a coating of chalk. They are taken out of the vats to be washed and placed in heaps, as they are useful for making concrete.

Now these bits of flint that while in the vats have

[1] Translation of a paper by M. Marcellin Boule in the *Comptes rendus* of the Paris Academy of Sciences (June 26).

undergone the dynamic action of an artificial whirlpool in all points comparable with the dynamic action of a torrential current of water, present all the characteristics of the ancient river-gravels; it is easy to find among them, after a few minutes' search, all the most characteristic forms of eoliths, such as are given as typical. My colleagues and I have been able to make a collection of flints admirably *retouchés*, identical with the forms called by M. Rutot hammer-stones, planes, notched flints, &c. We have also collected flints showing the cone of percussion, which is generally regarded as an infallible mark of intentional fashioning.

THE BRITISH ASSOCIATION.

Inaugural Address by Prof. G. H. Darwin, M.A., LL.D., Ph.D., F.R.S., President of the Association.

Part II.[1]

Thus far we have been concerned with the almost inconceivably minute, and I now propose to show that similar conditions prevail on a larger scale.

Many geological problems might well be discussed from my present point of view, yet I shall pass them by, and shall proceed at once to Astronomy, beginning with the smallest cosmical scale of magnitude, and considering afterwards the larger celestial phenomena.

The problems of cosmical evolution are so complicated that it is well to conduct the attack in various ways at the same time. Although the several theories may seem to some extent discordant with one another, yet, as I have already said, we ought not to scruple to carry each to its logical conclusion. We may be confident that in time the false will be eliminated from each theory, and when the true alone remains the reconciliation of apparent disagreements will have become obvious.

The German astronomer Bode long ago propounded a simple empirical law concerning the distances at which the several planets move about the sun. It is true that the planet Neptune, discovered subsequently, was found to be considerably out of the place which would be assigned to it by Bode's law, yet his formula embraces so large a number of cases with accuracy that we are compelled to believe that it arises in some manner from the primitive conditions of the planetary system.

The explanation of the causes which have led to this simple law as to the planetary distances presents an interesting problem, and, although it is still unsolved, we may obtain some insight into its meaning by considering what I have called a working model of ideal simplicity.

Imagine then a sun round which there moves in a circle a single large planet. I will call this planet Jove, because it may be taken as a representative of our largest planet, Jupiter. Suppose next that a meteoric stone or small planet is projected in any perfectly arbitrary manner in the same plane in which Jove is moving; then we ask how this third body will move. The conditions imposed may seem simple, yet the problem has so far overtaxed the powers of the mathematician that nothing approaching a general answer to our question has yet been given. We know, however, that under the combined attractions of the sun and Jove the meteoric stone will in general describe an orbit of extraordinary complexity, at one time moving slowly at a great distance from both the sun and Jove, at other times rushing close past one or other of them. As it grazes past Jove or the sun it may often but just escape a catastrophe, but a time will come at length when it runs its chances too fine and comes into actual collision. The individual career of the stone is then ended by absorption, and of course by far the greater chance is that it will find its Nirvana by absorption in the sun.

Next let us suppose that instead of one wandering meteoric stone or minor planet there are hundreds of them, moving initially in all conceivable directions. Since they are all supposed to be very small, their mutual attractions will be insignificant, and they will each move almost as though they were influenced only by the sun and Jove.

[1] Delivered at Johannesburg on August 30. The first part of the Address, delivered at Cape Town on August 15, appeared in Nature of August 17.

Most of these stones will be absorbed by the sun, and the minority will collide with Jove.

When we inquire how long the career of a stone may be, we find that it depends on the direction and speed with which it is started, and that by proper adjustment the delay of the final catastrophe may be made as long as we please. Thus by making the delay indefinitely long we reach the conception of a meteoric stone which moves so as never to come into collision with either body.

There are, therefore, certain perpetual orbits in which a meteoric stone or minor planet may move for ever without collision. But when such an immortal career has been discovered for our minor planet, it still remains to discover whether the slightest possible departure from the prescribed orbit will become greater and greater and ultimately lead to a collision with the sun or Jove, or whether the body will travel so as to cross and re-cross the exact perpetual orbit, always remaining close to it. If the slightest departure inevitably increases as time goes on, the orbit is unstable; if, on the other hand, it only leads to a slight waviness in the path described, it is stable.

We thus arrive at another distinction: there are perpetual orbits, but some, and indeed most, are unstable, and these do not offer an immortal career for a meteoric stone; and there are other perpetual orbits which are stable or persistent. The unstable ones are those which succumb in the struggle for life, and the stable ones are the species adapted to their environment.

If, then, we are given a system of a sun and large planet, together with a swarm of small bodies moving in all sorts of ways, the sun and planet will grow by accretion, gradually sweeping up the dust and rubbish of the system, and there will survive a number of small planets and satellites moving in certain definite paths. The final outcome will be an orderly planetary system in which the various orbits are arranged according to some definite law.

But the problem presented even by a system of such ideal simplicity is still far from having received a complete solution. No general plan for determining perpetual orbits has yet been discovered, and the task of discriminating the stable from the unstable is arduous. But a beginning has been made in the determination of some of the zones surrounding the sun and Jove in which stable orbits are possible, and others in which they are impossible. There is hardly room for doubt that if a complete solution for our solar system were attainable, we should find that the orbits of the existing planets and satellites are numbered amongst the stable perpetual orbits, and should thus obtain a rigorous mechanical explanation of Bode's law concerning the planetary distances.

It is impossible not to be struck by the general similarity between the problem presented by the corpuscles moving in orbits in the atom, and that of the planets and satellites moving in a planetary system. It may not, perhaps, be fanciful to imagine that some general mathematical method devised for solving a problem of cosmical evolution may find another application to miniature atomic systems, and may thus lead onward to vast developments of industrial mechanics. Science, however diverse its aims, is a whole, and men of science do well to impress on the captains of industry that they should not look askance on those branches of investigation which may seem for the moment far beyond any possibility of practical utility.

You will remember that I discussed the question as to whether the atomic communities of corpuscles could be regarded as absolutely eternal, and that I said that the analogy of other moving systems pointed to their ultimate mortality. Now the chief analogy which I had in my mind was that of a planetary system.

The orbits of which I have spoken are only perpetual when the bodies are infinitesimal in mass, and meet with no resistance as they move. Now the infinitesimal body does not exist, and both Lord Kelvin and Poincaré concur in holding that disturbance will ultimately creep in to any system of bodies moving even in so-called stable orbits; and this is so even apart from the resistance offered to the moving bodies by any residual gas there may be scattered through space. The stability is therefore only relative, and a planetary system contains the seeds of its own destruction. But this ultimate fate need not disturb

us either practically or theoretically, for the solar system contains in itself other seeds of decay which will probably bear fruit long before the occurrence of any serious disturbance of the kind of which I speak.

Before passing on to a new topic I wish to pay a tribute to the men to whom we owe the recent great advances in theoretical dynamical astronomy. As treated by the master-hands of Lagrange and Laplace and their successors, this branch of science hardly seemed to afford scope for any great new departure. But that there is always room for discovery, even in the most frequented paths of knowledge, was illustrated when, nearly thirty years ago, Hill of Washington proposed a new method of treating the theory of the moon's motion in a series of papers which have become classical. I have not time to speak of the enormous labour and great skill involved in the completion of Hill's Lunar Theory, by Ernest Brown, whom I am glad to number amongst my pupils and friends; for I must confine myself to other aspects of Hill's work.

The title of Hill's most fundamental paper, namely, "On Part of the Motion of the Lunar Perigee," is almost comic in its modesty, for who would suspect that it contains the essential points involved in the determination of perpetual orbits and their stability? Probably Hill himself did not fully realise at the time the full importance of what he had done. Fortunately he was followed by Poincaré, who not only saw its full meaning but devoted his incomparable mathematical powers to the full theoretical development of the point of view I have been laying before you.

Other mathematicians have also made contributions to this line of investigation, amongst whom I may number my friend Mr. Hough, chief assistant at the Royal Observatory of Cape Town, and myself. But without the work of our two great forerunners we should still be in utter darkness, and it would have been impossible to give even this slight sketch of a great subject.

The theory which I have now explained points to the origin of the sun and planets from gradual accretions of meteoric stones, and it makes no claim to carry the story back behind the time when there was already a central condensation or sun about which there circled another condensation or planet. But more than a century ago an attempt had already been made to re-construct the history back to a yet remoter past, and, as we shall see, this attempt was based upon quite a different supposition as to the constitution of the primitive solar system. I myself believe that the theory I have just explained, as well as that to which I am coming, contains essential elements of truth, and that the apparent discordances will some day be reconciled. The theory of which I speak is the celebrated nebular hypothesis, first suggested by the German philosopher Kant, and later re-stated independently and in better form by the French mathematician Laplace.

Laplace traced the origin of the solar system to a nebula or cloud of rarefied gas congregated round a central condensation which was ultimately to form the sun. The whole was slowly rotating about an axis through its centre, and, under the combined influences of rotation and of the mutual attraction of the gas, it assumed a globular form, slightly flattened at the poles. The justifiability of this supposition is confirmed by the observations of astronomers, for they find in the heavens many nebulæ, while the spectroscope proves that their light at any rate is derived from gas. The primeval globular nebula is undoubtedly a stable or persistent figure, and thus Laplace's hypothesis conforms to the general laws which I have attempted to lay down.

The nebula must have gradually cooled by radiation into space, and as it did so the gas must necessarily have lost some of its spring or elasticity. This loss of power of resistance then permitted the gas to crowd more closely towards the central condensation, so that the nebula contracted. The contraction led to two results, both inevitable according to the laws of mechanics: first, the central condensation became hotter; and, secondly, the speed of its rotation became faster. The accelerated rotation led to an increase in the amount of polar flattening, and the nebula at length assumed the form of a lens, or of a disc thicker in the middle than at the edges. Assuming the existence of the primitive nebula, the hypothesis may be accepted thus far as practically certain.

From this point, however, doubt and difficulty enter into the argument. It is supposed that the nebula became so much flattened that it could not subsist as a continuous aggregation of gas, and a ring of matter detached itself from the equatorial regions. The central portions of the nebula, when relieved of the excrescence, resumed the more rounded shape formerly possessed by the whole. As the cooling continued the central portion in its turn became excessively flattened through the influence of its increased rotation; another equatorial ring then detached itself, and the whole process was repeated as before. In this way the whole nebula was fissured into a number of rings surrounding the central condensation, the temperature of which must by then have reached incandescence.

Each ring then aggregated itself round some nucleus which happened to exist in its circumference, and so formed a subordinate nebula. Passing through a series of transformations, like its parent, this nebula was finally replaced by a planet with attendant satellites.

The whole process forms a majestic picture of the history of our system. But the mechanical conditions of a rotating nebula are too complex to admit, as yet, of complete mathematical treatment; and thus, in discussing this theory, the physicist is compelled in great measure to adopt the qualitative methods of the biologist, rather than the quantitative ones which he would prefer.

The telescope seems to confirm the general correctness of Laplace's hypothesis. Thus, for example, the great nebula in Andromeda presents a grand illustration of what we may take to be a planetary system in course of formation. In it we see the central condensation surrounded by a more or less ring-like nebulosity, and in one of the rings there appears to be a subordinate condensation.

Nevertheless it is hardly too much to say that every stage in the supposed process presents to us some difficulty or impossibility. Thus we ask whether a mass of gas of almost inconceivable tenuity can really rotate all in one piece, and whether it is not more probable that there would be a central whirlpool surrounded by more slowly-moving parts. Again, is there any sufficient reason to suppose that a series of intermittent efforts would lead to the detachment of distinct rings, and is not a continuous outflow of gas from the equator more probable?

The ring of Saturn seems to have suggested the theory to Laplace; but to take it as a model leads us straight to a quite fundamental difficulty. If a ring of matter ever concentrates under the influence of its mutual attraction, it can only do so round the centre of gravity of the whole ring. Therefore the matter forming an approximately uniform ring, if it concentrates at all, can only fall in on the parent planet and be re-absorbed. Some external force other than the mutual attraction of the matter forming the ring, and therefore not provided by the theory, seems necessary to effect the supposed concentration. The only way of avoiding this difficulty is to suppose the ring to be ill-balanced or lop-sided; in this case, provided the want of balance is pronounced enough, concentration will take place round a point inside the ring but outside the planet. Many writers assume that the present distances of the planets preserve the dimensions of the primitive rings; but the argument that a ring can only aggregate about its centre of gravity, which I do not recollect to have seen before, shows that such cannot be the case.

The concentration of an ill-balanced or broken ring on an interior point would necessarily generate a planet with direct rotation—that is to say, rotating in the same direction as the earth. But several writers, and notably Faye, endeavour to show—erroneously as I think—that a retrograde rotation should be normal, and they are therefore driven to make various complicated suppositions to explain the observed facts. But I do not claim to have removed the difficulty, only to have shifted it; for the satellites of Neptune, and presumably the planet itself, have retrograde rotations; and, lastly, the astonishing discovery has just been made by William Pickering of a ninth retrograde satellite of Saturn, while the rotations of the eight other satellites, of the ring and of the planet itself, are direct. Finally, I express a doubt as to whether the telescope

does really exactly confirm the hypothesis of Laplace, for I imagine that what we see indicates a spiral rather than a ring-like division of nebulæ.[1]

This is not the time to pursue these considerations further, but enough has been said to show that the nebular hypothesis cannot be considered as a connected intelligible whole, however much of truth it may contain.

In the first theory which I sketched as to the origin of the sun and planets, we supposed them to grow by the accretions of meteoric wanderers in space, and this hypothesis is apparently in fundamental disagreement with the conception of Laplace, who considered the transformations of a continuous gaseous nebula. Some years ago a method occurred to me by which these two discordant schemes of origin might perhaps be reconciled. A gas is not really continuous, but it consists of a vast number of molecules moving in all directions with great speed and frequently coming into collision with one another. Now I have ventured to suggest that a swarm of meteorites would, by frequent collisions, form a medium endowed with so much of the mechanical properties of a gas as would satisfy Laplace's conditions. If this is so, a nebula may be regarded as a quasi-gas, the molecules of which are meteorites. The gaseous luminosity which undoubtedly is sent out by nebulæ would then be due only to incandescent gas generated by the clash of meteorites, while the dark bodies themselves would remain invisible. Sir Norman Lockyer finds spectroscopic evidence which led him long ago to some such view as this, and it is certainly of interest to find in his views a possible means of reconciling two apparently totally discordant theories.[2] However, I do not desire to lay much stress on my suggestion, for without doubt a swarm of meteors could only maintain the mechanical properties of a gas for a limited time, and, as pointed out by Prof. Chamberlin, it is difficult to understand how a swarm of meteorites moving indiscriminately in every direction could ever have come into existence. But my paper may have served to some extent to suggest to Chamberlin his recent modification of the nebular hypothesis, in which he seeks to reconcile Laplace's view with a meteoritic origin of the planetary system.[3]

We have seen that, in order to explain the genesis of planets according to Laplace's theory, the rings must be ill-balanced or even broken. If the ring were so far from being complete as only to cover a small segment of the whole circumference, the true features of the occurrences in the births of planets and satellites might be better represented by conceiving the detached portion of matter to have been more or less globular from the first, rather than ring-shaped. Now this idea introduces us to a group of researches whereby mathematicians have sought to explain the birth of planets and satellites in a way which might appear, at first sight, to be fundamentally different from that of Laplace.

The solution of the problem of evolution involves the search for those persistent or stable forms which biologists would call species. The species of which I am now going to speak may be grouped in a family, which comprises all those various forms which a mass of rotating liquid is capable of assuming under the conjoint influences of gravitation and rotation. If the earth were formed throughout of a liquid of the same density, it would be one of the species of this family; and indeed these researches date back to the time of Newton, who was the first to explain the figures of planets.

The ideal liquid planets we are to consider must be regarded as working models of actuality, and inasmuch as the liquid is supposed to be incompressible, the conditions depart somewhat widely from those of reality. Hence, when the problem has been solved, much uncertainty remains as to the extent to which our conclusions will be applicable to actual celestial bodies.

We begin, then, with a rotating liquid planet like the earth, which is the first stable species of our family. We next impart in imagination more rotation to this planet, and find by mathematical calculation that its power of resistance to any sort of disturbance is less than it was. In other words, its stability declines with increased rotation, and at length we reach a stage at which the stability just vanishes. At this point the shape is a transitional one, for it is the beginning of a new species with different characteristics from the first, and with a very feeble degree of stability or power of persistence. As a still further amount of rotation is imparted, the stability of the new species increases to a maximum and then declines until a new transitional shape is reached and a new species comes into existence. In this way we pass from species to species with an ever-increasing amount of rotation.

The first or planetary species has a circular equator like the earth; the second species has an oval equator, so that it is something like an egg spinning on its side on a table; in the third species we find that one of the two ends of the egg begins to swell, and that the swelling gradually becomes a well-marked protrusion or filament. Finally the filamentous protrusion becomes bulbous at its end, and is only joined to the main mass of liquid by a gradually thinning neck. The neck at length breaks, and we are left with two separated masses which may be called planet and satellite. It is fair to state that the actual rupture into two bodies is to some extent speculative, since mathematicians have hitherto failed to follow the whole process to the end.

In this ideal problem the successive transmutations of species are brought about by gradual additions to the amount of rotation with which the mass of liquid is endowed. It might seem as if this continuous addition to the amount of rotation were purely arbitrary and could have no counterpart in nature. But real bodies cool and contract in cooling, and, since the scale of magnitude on which our planet is built is immaterial, contraction will produce exactly the same effect on shape as augmented rotation. I must ask you, then, to believe that the effects of an apparently arbitrary increase of rotation may be produced by cooling.

The figures which I succeeded in drawing, by means of rigorous calculation, of the later stages of this course of evolution, are so curious as to remind one of some such phenomenon as the protrusion of a filament of protoplasm from a mass of living matter, and I suggest that we may see in this almost life-like process the counterpart of at least one form of the birth of double stars, planets, and satellites.

As I have already said, Newton determined the first of these figures; Jacobi found the second, and Poincaré indicated the existence of the third, in a paper which is universally regarded as one of the masterpieces of applied mathematics; finally I myself succeeded in determining the exact form of Poincaré's figure, and in proving that it is a true stable shape.

My Cambridge colleague Jeans has also made an interesting contribution to the subject by discussing a closely analogous problem, and he has besides attacked the far more difficult case where the rotating fluid is a compressible gas. In this case also he finds a family of types, but the conception of compressibility introduced a new set of considerations in the transitions from species to species. The problem is, however, of such difficulty that he had to rest content with results which were rather qualitative than strictly quantitative.

This group of investigations brings before us the process of the birth of satellites in a more convincing form than was possible by means of the general considerations adduced by Laplace. It cannot be doubted that the supposed Laplacian sequence of events possesses a considerable element of truth, yet these latter schemes of transformation can be followed in closer detail. It seems, then, probable that both processes furnish us with crude models of reality, and that in some cases the first and in others the second is the better representative.

The moon's mass is one-eightieth of that of the earth, whereas the mass of Titan, the largest satellite in the solar system, is 1/4600 of that of Saturn. On the ground of this great difference between the relative magnitudes of all other satellites and of the moon, it is not unreasonable to suppose that the mode of separation of the moon from the earth may also have been widely different. The

[1] Prof. Chamberlin, of Chicago, has recently proposed a modified form of the nebular hypothesis, in which he contends that the spiral form is normal. See "Year Book," No. 3, for 1904, of the Carnegie Institution of Washington, pp. 195–258.

[2] Newcomb considers the objections to Lockyer's theory insuperable. See p. 190 of "The Stars." (London: John Murray, 1904.)

[3] See preceding reference to Chamberlin's paper.

theory of which I shall have next to speak claims to trace the gradual departure of the moon from an original position not far removed from the present surface of the earth. If this view is correct, we may suppose that the detachment of the moon from the earth occurred as a single portion of matter, and not as a concentration of a Laplacian ring.

If a planet is covered with oceans of water and air, or if it is formed of plastic molten rock, tidal oscillations must be generated in its mobile parts by the attractions of its satellites and of the sun. Such movements must be subject to frictional resistance, and the planet's rotation will be slowly retarded by tidal friction in much the same way that a fly-wheel is gradually stopped by any external cause of friction. Since action and reaction are equal and opposite, the action of the satellites on the planet, which causes the tidal friction of which I speak, must correspond to a reaction of the planet on the motion of the satellites.

At any moment of time we may regard the system composed of the rotating planet with its attendant satellite as a stable species of motion, but the friction of the tides introduces forces which produce a continuous, although slow, transformation in the configuration. It is, then, clearly of interest to trace backwards in time the changes produced by such a continuously acting cause, and to determine the initial condition from which the system of planet and satellite must have been slowly degrading. We may also look forward, and discover whither the transformation tends.

Let us consider, then, the motion of the earth and moon revolving in company round the sun, on the supposition that the friction of the tides in the earth is the only effective cause of change. We are, in fact, to discuss a working model of the system, analogous to those of which I have so often spoken before.

This is not the time to attempt a complete exposition of the manner in which tidal friction gives rise to the action and reaction between planet and satellite, nor shall I discuss in detail the effects of various kinds which are produced by this cause. It must suffice to set forth the results in their main outlines, and, as in connection with the topic of evolution retrospect is perhaps of greater interest than prophecy, I shall begin with the consideration of the past.

At the present time the moon, moving at a distance of 240,000 miles from the earth, completes her circuit in twenty-seven days. Since a day is the time of one rotation of the earth on its axis, the angular motion of the earth is twenty-seven times as rapid as that of the moon.

Tidal friction acts as a brake on the earth, and therefore we look back in retrospect to times when the day was successively twenty-three, twenty-two, twenty-one of our present hours in length, and so on backward to still shorter days. But during all this time the reaction on the moon was at work, and it appears that its effect must have been such that the moon also revolved round the earth in a shorter period than it does now; thus the month also was shorter in absolute time than it now is. These conclusions are absolutely certain, although the effects on the motions of the earth and of the moon are so gradual that they can only doubtfully be detected by the most refined astronomical measurements.

We take the "day," regarding it as a period of variable length, to mean the time occupied by a single rotation of the earth on its axis; and the "month," likewise variable in absolute length, to mean the time occupied by the moon in a single revolution round the earth. Then, although there are now twenty-seven days in a month, and although both day and month were shorter in the past, yet there is, so far, nothing to tell us whether there were more or fewer days in the month in the past. For if the day is now being prolonged more rapidly than the month, the number of days in the month was greater in the past than it now is; and if the converse were true, the number of days in the month was less.

Now it appears from mathematical calculation that the day must now be suffering a greater degree of prolongation than the month, and accordingly in retrospect we look back to a time when there were more days in the month than at present. That number was once twenty-nine, in place of the present twenty-seven; but the epoch of twenty-nine days in the month is a sort of crisis in the history of moon and earth, for yet earlier the day was shortening less rapidly than the month. Hence, earlier than the time when there were twenty-nine days in the month, there was a time when there was a reversion to the present smaller number of days.

We thus arrive at the curious conclusion that there is a certain number of days to the month, namely twenty-nine, which can never have been exceeded, and we find that this crisis was passed through by the earth and moon recently; but, of course, a recent event in such a long history may be one which happened some millions of years ago.

Continuing our retrospect beyond this crisis, both day and month are found continuously shortening, and the number of days in the month continues to fall. No change in conditions which we need pause to consider now supervenes, and we may ask at once, what is the initial stage to which the gradual transformation points? I say, then, that on following the argument to its end the system may be traced back to a time when the day and month were identical in length, and were both only about four or five of our present hours. The identity of day and month means that the moon was always opposite to the same side of the earth; thus at the beginning the earth always presented the same face to the moon, just as the moon now always shows the same face to us. Moreover, when the month was only some four or five of our present hours in length the moon must have been only a few thousand miles from the earth's surface—a great contrast with the present distance of 240,000 miles.

It might well be argued from this conclusion alone that the moon separated from the earth more or less as a single portion of matter at a time immediately antecedent to the initial stage to which she has been traced. But there exists a yet more weighty argument favourable to this view, for it appears that the initial stage is one in which the stability of the species of motion is tottering, so that the system presents the characteristic of a transitional form, which we have seen to denote a change of type or species in a previous case.

In discussing the transformations of a liquid planet we saw the tendency of the single mass to divide into two portions, although we failed to extend the rigorous argument back to the actual moment of separation; and now we seem to reach a similar crisis from the opposite end, when in retrospect we trace back the system to two masses of unequal size in close proximity with one another. The argument almost carries conviction with it, but I have necessarily been compelled to pass over various doubtful points.

Time is wanting to consider other subjects worthy of notice which arise out of this problem, yet I wish to point out that the earth's axis must once have been less tilted over with reference to the sun than it is now, so that the obliquity of the ecliptic receives at least a partial explanation. Again, the inclination of the moon's orbit may be in great measure explained; and, lastly, the moon must once have moved in a nearly circular path. The fact that tidal friction is competent to explain the eccentricity of an orbit has been applied in a manner to which I shall have occasion to return hereafter.

In my paper on this subject I summed up the discussion in the following words, which I still see no reason to retract:—

"The argument reposes on the imperfect rigidity of solids, and on the internal friction of semi-solids and fluids; these are *verae causae*. Thus changes of the kind here discussed must be going on, and must have gone on in the past. And for this history of the earth and moon to be true throughout it is only necessary to postulate a sufficient lapse of time, and that there is not enough matter diffused through space materially to resist the motions of the moon and earth in perhaps several hundred million years.

"It hardly seems too much to say that granting these two postulates and the existence of a primeval planet, such as that above described, then a system would necessarily be developed which would bear a strong resemblance to our own.

"A theory, reposing on *verae causae*, which brings into

quantitative correlation the lengths of the present day and month, the obliquity of the ecliptic, and the inclination and eccentricity of the lunar orbit, must, I think, have strong claims to acceptance."[1]

We have pursued the changes into the past, and I will refer but shortly to the future. The day and month are both now lengthening, but the day changes more quickly than the month. Thus the two periods tend again to become equal to one another, and it appears that when that goal is reached both day and month will be as long as fifty-five of our present days. The earth will then always show the same face to the moon, just as it did in the remotest past. But there is a great contrast between the ultimate and initial conditions, for the ultimate stage, with day and month both equal to fifty-five of our present days, is one of great stability in contradistinction to the vanishing stability which we found in the initial stage.

Since the relationship between the moon and earth is a mutual one, the earth may be regarded as a satellite of the moon, and if the moon rotated rapidly on her axis, as was probably once the case, the earth must at that time have produced tides in the moon. The mass of the moon is relatively small, and the tides produced by the earth would be large; accordingly the moon would pass through the several stages of her history much more rapidly than the earth. Hence it is that the moon has already advanced to that condition which we foresee as the future fate of the earth, and now always shows to us the same face.

If the earth and moon were the only bodies in existence, this ultimate stage when the day and month were again identical in length would be one of absolute stability, and therefore eternal; but the presence of the sun introduces a cause for yet further changes. I do not, however, propose to pursue the history to this yet remoter futurity, because our system must contain other seeds of decay which will probably bear fruit before these further transformations could take effect.

If, as has been argued, tidal friction has played so important a part in the history of the earth and moon, it might be expected that the like should be true of the other planets and satellites, and of the planets themselves in their relationship to the sun. But numerical examination of the several cases proves conclusively that this cannot have been the case. The relationship of the moon to the earth is in fact quite exceptional in the solar system, and we have still to rely on such theories as that of Laplace for the explanation of the main outlines of the solar system.

I have as yet only barely mentioned the time occupied by the sequence of events sketched out in the various schemes of cosmogony, and the question of cosmical time is a thorny and controversial one.

Our ideas are absolutely blank as to the time requisite for the evolution according to Laplace's nebular hypothesis. And again, if we adopt the meteoritic theory, no estimate can be formed of the time required even for an ideal sun, with its attendant planet Jove, to sweep up the wanderers in space. We do know, indeed, that there is a continuous gradation from stable to unstable orbits, so that some meteoric stones may make thousands or millions of revolutions before meeting their fate by collision. Accordingly, not only would a complete absorption of all the wanderers occupy an infinite time, but also the amount of the refuse of the solar system still remaining scattered in planetary space is unknown. And, indeed, it is certain that the process of clearance is still going on, for the earth is constantly meeting meteoric stones, which, penetrating the atmosphere, become luminous through the effects of the frictional resistance with which they meet.

All we can assert of such theories is that they demand enormous intervals of time as estimated in years.

The theory of tidal friction stands alone amongst these evolutionary speculations in that we can establish an exact but merely relative time-scale for every stage of the process. It is true that the value in years of the unit of time remains unknown, and it may be conjectured that the unit has varied to some extent as the physical condition of the earth has gradually changed.

1 *Phil. Trans.*, pt. ii., 1880, p. 883.

It is, however, possible to determine a period in years which must be shorter than that in which the whole history is comprised. If at every moment since the birth of the moon tidal friction had always been at work in such a way as to produce the greatest possible effect, then we should find that sixty million years would be consumed in this portion of evolutionary history. The true period must be much greater, and it does not seem extravagant to suppose that 500 to 1000 million years may have elapsed since the birth of the moon.

Such an estimate would not seem extravagant to geologists who have, in various ways, made exceedingly rough determinations of geological periods. One such determination is derived from measures of the thickness of deposited strata, and the rate of the denudation of continents by rain and rivers. I will not attempt to make any precise statement on this head, but I imagine that the sort of unit with which the geologist deals is 100 million years, and that he would not consider any estimate involving from one to twenty of such units as unreasonable.

Mellard Reade has attempted to determine geological time by certain arguments as to the rate of denudation of limestone rocks, and arrives at the conclusion that geological history is comprised in something less than 600 million years.[1] The uncertainty of this estimate is wide, and I imagine that geologists in general would not lay much stress on it.

Joly has employed a somewhat similar, but probably less risky, method of determination.[2] When the earth was still hot, all the water of the globe must have existed in the form of steam, and when the surface cooled that steam must have condensed as fresh water. Rain then washed the continents and carried down detritus and soluble matter to the seas. Common salt is the most widely diffused of all such soluble matter, and its transit to the sea is an irreversible process, because the evaporation of the sea only carries back to the land fresh water in the form of rain. It seems certain, then, that the saltness of the sea is due to the washing of the land throughout geological time.

Rough estimates may be formed of the amount of river water which reaches the sea in a year, and the measured saltness of rivers furnishes a knowledge of the amount of salt which is thus carried to the sea. A closer estimate may be formed of the total amount of salt in the sea. On dividing the total amount of salt by the annual transport Joly arrives at the quotient of about 100 millions, and thence concludes that geological history has occupied 100 million years. I will not pause to consider the several doubts and difficulties which arise in the working out of this theory. The uncertainties involved must clearly be considerable, yet it seems the best of all the purely geological arguments whence we derive numerical estimates of geological time. On the whole I should say that pure geology points to some period intermediate between 50 and 1000 millions of years, but the upper limit is more doubtful than the lower. Thus far we do not find anything which renders the tidal theory of evolution untenable.

But the physicists have formed estimates in other ways which, until recently, seemed to demand in the most imperative manner a far lower scale of time. According to all theories of cosmogony, the sun is a star which became heated in the process of its condensation from a condition of wide dispersion. When a meteoric stone falls into the sun the arrest of its previous motion gives rise to heat, just as the blow of a horse's shoe on a stone makes a spark. The fall of countless meteoric stones, or the condensation of a rarefied gas, was supposed to be the sole cause of the sun's high temperature.

Since the mass of the sun is known, the total amount of the heat generated in it, in whatever mode it was formed, can be estimated with a considerable amount of precision. The heat received at the earth from the sun can also be measured with some accuracy, and hence it is a mere matter of calculation to determine how much heat the sun sends out in a year. The total heat which can have been generated in the sun divided by the annual

1 "Chemical Denudation in Relation to Geological Time," Bogue, London, 1879; or Roy. Soc., January 23, 1879.

2 "An Estimate of the Geological Age of the Earth," *Trans. Roy. Dub. Soc.*, vol. vii. series iii., 1902, pp. 23–66.

output gives a quotient of about 20 millions. Hence it seemed to be imperatively necessary that the whole history of the solar system should be comprised within some 20 millions of years.

This argument, which is due to Helmholtz, appeared to be absolutely crushing, and for the last forty years the physicists have been accustomed to tell the geologists that they must moderate their claims. But for myself I have always believed that the geologists were more nearly correct than the physicists, notwithstanding the fact that appearances were so strongly against them.

And now, at length, relief has come to the strained relations between the two parties, for the recent marvellous discoveries in physics show that concentration of matter is not the only source from which the sun may draw its heat.

Radium is a substance which is perhaps millions of times more powerful than dynamite. Thus it is estimated that an ounce of radium would contain enough power to raise 10,000 tons a mile above the earth's surface. Another way of stating the same estimate is this: the energy needed to tow a ship of 12,000 tons a distance of six thousand sea miles at 15 knots is contained in 22 ounces of radium. The *Saxon* probably burns five or six thousand tons of coal on a voyage of approximately the same length. Again, M. and Mme. Curie have proved that radium actually gives out heat,[1] and it has been calculated that a small proportion of radium in the sun would suffice to explain its present radiation. Other lines of argument tend in the same direction.[2]

Now we know that the earth contains radio-active materials, and it is safe to assume that it forms in some degree a sample of the materials of the solar system. Hence it is almost certain that the sun is radio-active also; and besides it is not improbable that an element with so heavy an atom as radium would gravitate more abundantly to the central condensation than to the outlying planets. In this case the sun should contain a larger proportion of radio-active material than the earth.

This branch of science is as yet but in its infancy, but we already see how unsafe it is to dogmatise on the potentialities of matter.

It appears, then, that the physical argument is not susceptible of a greater degree of certainty than that of the geologists, and the scale of geological time remains in great measure unknown.

I have now ended my discussion of the solar system, and must pass on to the wider fields of the stellar universe.

Only a few thousand stars are visible with the unaided eye, but photography has revealed an inconceivably vast multitude of stars and nebulæ, and every improvement in that art seems to disclose yet more and more. About twenty years ago the number of photographic objects in the heavens was roughly estimated at about 170 millions, and some ten years later it had increased to about 400 millions. Although Newcomb, in his recent book on "The Stars," refrains even from conjecturing any definite number, yet I suppose that the enormous number of 400 million must now be far below the mark, and photography still grows better year by year. It seems useless to consider whether the number of stars has any limit, for infinite number, space, and time transcend our powers of comprehension. We must then make a virtue of necessity, and confine our attention to such more limited views as seem within our powers.

A celestial photograph looks at first like a dark sheet of paper splashed with whitewash, but further examination shows that there is some degree of method in the arrangement of the white spots. It may be observed that the stars in many places are arranged in lines and sweeping trains, and chains of stars, arranged in roughly parallel curves, seem to be drawn round some centre. A surface splashed at hazard might present apparent evidence of system in a few instances, but the frequency of the occurrence in the heavens renders the hypothesis of mere chance altogether incredible.

[1] Lord Kelvin has estimated the age of the earth from the rate of increase of temperature underground. But the force of his argument seems to be entirely destroyed by this result.

[2] See W. E. Wilson, NATURE, July 9, 1903; and G. H. Darwin, NATURE, September 24, 1903.

Thus there is order of some sort in the heavens, and, although no reason can be assigned for the observed arrangement in any particular case, yet it is possible to obtain general ideas as to the succession of events in stellar evolution.

Besides the stars there are numerous streaks, wisps, and agglomerations of nebulosity, the light of which we know to emanate from gas. Spots of intenser light are observed in less brilliant regions; clusters of stars are sometimes imbedded in nebulosity, while in other cases each individual star of a cluster stands out clear by itself. These and other observations force on us the conviction that the wispy clouds represent the earliest stage of development, the more condensed nebulæ a later stage, and the stars themselves the last stage. This view is in agreement with the nebular hypothesis of Laplace, and we may fairly conjecture that the chains and lines of stars represent pre-existing streaks of nebulosity.

As a star cools it must change, and the changes which it undergoes constitute its life-history, hence the history of a star presents an analogy with the life of an individual animal. Now, the object which I have had in view has been to trace types or species in the physical world through their transformations into other types. Accordingly it falls somewhat outside the scope of this address to consider the constitution and history of an individual star, interesting although those questions are. I may, however, mention that the constitution of gaseous stars was first discussed from the theoretical side by Lane, and subsequently more completely by Ritter. On the observational side the spectroscope has proved to be a powerful instrument in analysing the constitutions of the stars, and in assigning to them their respective stages of development.

If we are correct in believing that stars are condensations of matter originally more widely spread, a certain space surrounding each star must have been cleared of nebulosity in the course of its formation. Much thought has been devoted to the determination of the distribution of the stars in space, and although the results are lacking in precision, yet it has been found possible to arrive at a rough determination of the average distance from star to star. It has been concluded, from investigations into which I cannot enter, that if we draw a sphere round the sun with a radius of twenty million millions of miles,[1] it will contain no other star; if the radius were twice as great the sphere might perhaps contain one other star; a sphere with a radius of sixty million millions of miles will contain about four stars. This serves to give some idea of the extraordinary sparseness of the average stellar population; but there are probably in the heavens urban and rural districts, as on earth, where the stars may be either more or less crowded. The stars are moving relatively to one another with speeds which are enormous, as estimated by terrestrial standards, but the distances which separate us from them are so immense that it needs refined observation to detect and measure the movements.

Change is obviously in progress everywhere, as well in each individual nebula and star as in the positions of these bodies relatively to one another. But we are unable even to form conjectures as to the tendency of the evolution which is going on. This being so, we cannot expect, by considering the distribution of stars and nebulæ, to find many illustrations of the general laws of evolution which I have attempted to explain; accordingly I must confine myself to the few cases where we at least fancy ourselves able to form ideas as to the stages by which the present conditions have been reached.

Up to a few years ago there was no evidence that the law of gravitation extended to the stars, and even now there is nothing to prove the transmission of gravity from star to star. But in the neighbourhood of many stars the existence of gravity is now as clearly demonstrated as within the solar system itself. The telescope has disclosed the double character of a large number of stars, and the relative motions of the pairs of companions have been observed with the same assiduity as that of the planets. When the relative orbit of a pair of binary or double stars is examined, it is found that the motion conforms exactly to those laws of Kepler which prove that the planets circle

[1] This is the distance at which the earth's distance from the sun would appear to be 1″.

round the sun under the action of solar gravitation. The success of the hypothesis of stellar gravitation has been so complete that astronomers have not hesitated to explain the anomalous motion of a seemingly single star by the existence of a dark companion; and it is interesting to know that the more powerful telescopes of recent times have disclosed, in at least two cases, a faintly luminous companion in the position which had been assigned to it by theory.

By an extension of the same argument, certain variations in the spectra of a considerable number of stars have been pronounced to prove them each to be really double, although in general the pair may be so distant that they will probably always remain single to our sight. Lastly, the variability in the light of other apparently single stars has proved them to be really double. A pair of stars may partially or wholly cover one another as they revolve in their orbit, and the light of the seemingly single star will then be eclipsed, just as a lighthouse winks when the light is periodically hidden by a revolving shutter. Exact measurements of the character of the variability in the light have rendered it possible not only to determine the nature of the orbit described, but even to discover the figures and densities of the two components which are fused together by the enormous distance of our point of view. This is a branch of astronomy to which much careful observation and skilful analysis has been devoted; and I am glad to mention that Alexander Roberts, one of the most eminent of the astronomers who have considered the nature of variable stars, is a resident in South Africa.

I must not, however, allow you to suppose that the theory of eclipses will serve to explain the variability of all stars, for there are undoubtedly others the periodicity of which must be explained by something in their internal constitution.

The periods of double stars are extremely various, and naturally those of short period have been the first noted; in times to come others with longer and longer periods will certainly be discovered. A leading characteristic of all these double stars is that the two companions do not differ enormously in mass from one another. In this respect these systems present a strongly marked contrast with that of the sun, attended as it is by relatively insignificant planets.

In the earlier part of my address I showed how theory indicates that a rotating fluid body will as it cools separate into two detached masses. Mathematicians have not yet been able to carry their analysis far enough to determine the relative magnitudes of the two parts, but so far as we can see the results point to the birth of a satellite the mass of which is a considerable fraction of that of its parent. Accordingly See (who devotes his attention largely to the astronomy of double stars), Roberts, and others consider that what they have observed in the heavens is in agreement with the indications of theory. It thus appears that there is reason to hold that double stars have been generated by the division of primitive and more diffused single stars.

But if this theory is correct we should expect the orbit of a double star to be approximately circular; yet this is so far from being the case that the eccentricity of the orbits of many double stars exceeds by far any of the eccentricities in the solar system. Now See has pointed out that when two bodies of not very unequal masses revolve round one another in close proximity the conditions are such as to make tidal friction as efficient as possible in transforming the orbit. Hence we seem to see in tidal friction a cause which may have sufficed not only to separate the two component stars from one another, but also to render the orbit eccentric.

I have thought it best to deal very briefly with stellar astronomy, in spite of the importance of the subject, because the direction of the changes in progress is in general too vague to admit of the formation of profitable theories.

We have seen that it is possible to trace the solar system back to a primitive nebula with some degree of confidence, and that there is reason to believe that the stars in general have originated in the same manner. But such primitive nebulæ stand in as much need of explanation as their stellar offspring. Thus, even if we grant the exact truth of these theories, the advance towards an explanation of the universe remains miserably slight. Man is but a microscopic being relatively to astronomical space, and he lives on a puny planet circling round a star of inferior rank. Does it not then seem as futile to imagine that he can discover the origin and tendency of the universe as to expect a housefly to instruct us as to the theory of the motions of the planets? And yet, so long as he shall last, he will pursue his search, and will no doubt discover many wonderful things which are still hidden. We may indeed be amazed at all that man has been able to find out, but the immeasurable magnitude of the undiscovered will throughout all time remain to humble his pride. Our children's children will still be gazing and marvelling at the starry heavens, but the riddle will never be read.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY REAR-ADMIRAL SIR W. J. L. WHARTON, K.C.B., F.R.S., PRESIDENT OF THE SECTION.

IT is sometimes denied to Geography that she has any right to consider herself as a science, the objection being apparently founded on the view that it is a subject that can be learnt by heart, but not studied on any systematic line or reduced to principles which enable advance to be made, as in the more exact sciences, by continual investigation by means of laws discovered in the course of such investigation. This, it appears to me, is a misapprehension due to an incomplete recognition of what Science is, and of what Geography is.

Science is, in its simplest interpretation, "knowledge," such knowledge as comes from an intimate acquaintance with and study of any subject duly coordinated and arranged. The subjects which the advancing education and civilisation of the world have caused to be minutely studied are very many, and as knowledge has increased specialisation has become a necessity, until the list of sciences is very long.

Science may be broadly divided into several categories.

Pure or Exact Science, such as Mathematics; Natural or Physical Science, which rests on observations of Nature; Moral Science, which treats of all mental phenomena.

Some Sciences are of ancient foundation, some have arisen from new inquiries and needs of man, or from fissure in subjects too wide for convenient treatment as one.

Many of them are capable of exact definition, and their boundaries and limits can be well marked.

To others no very distinct limitations can be assigned. From their nature they overlap and are overlapped by other subjects, and it is impracticable to confine them by a strict line.

Geography is one of the latter.

Geography is one of the most ancient subjects studied with the view of coordinating facts. A desire for exact knowledge of, first, the bearings and distances of one place from another for the purposes of intercommunication must have arisen as soon as men became collected into groups whose growing civilisation and needs required travel to obtain what could not be obtained in the community. This was the earliest form of Geography, and it is an aspect which still remains, and to some is, in the modern shape of maps, the principal, if not the sole, end of Geography.

From the earliest times, however, geographical information included other than topographical data.

It was soon found that for the traveller and statesman, whether in peace or war, more was wanted to enable Geography to supply requirements.

The nature of a country, the supply of food and water, the characters of the rivers, the manners and customs of the inhabitants, their language and affinities, the climate, and other matters, were all of much moment, and Geography dealt with them all, being, as its name denotes, in the broadest sense a "description of the earth."

After the first crude guesses of relative positions,

founded on times occupied on journeys, other knowledge was enlisted in the cause.

Astronomy was soon recognised as the only means by which to ascertain the distances of places far apart and separated by seas, but for many centuries this could only be applied to latitude. Still the scientific geographer had to study and use the astronomical and geodetic methods known.

As knowledge increased, the subjects became too wide to be strictly considered as one study, and many have become the objects of special research under different titles.

Geodesy deals with the precise form of the earth and its dimensions.

Geology studies the nature of the materials forming the earth's crust, and the changes in it in past ages.

Ethnology and *Anthropology* treat of the different races of mankind.

The study of *Economics* takes note of the conditions of communities and nations, their laws and systems of government.

Botany and *Zoology* now concern themselves with the details of vegetable and animal life.

Archæology investigates the remains of past civilisations which cover the earth.

Meteorology strives to unravel and reduce to law the complicated conditions of the atmosphere, its continual movements, and the results which have such varying effect on our daily life.

Oceanography, the study of the phenomena of the sea as distinct from the dry land, is still regarded as an integral part of Geography, but is rapidly becoming a subject by itself.

Of all these subjects Geography may be considered to be the parent; and though the family be large and has gone off on many separate lines, it is necessary when taking a large and comprehensive view of the united results of knowledge thus gained, especially from the point of view of Distribution, to return to that parent and consider them on a general or geographical basis.

I cannot pretend to define Geographical Science in a clearer or shorter form than that in which it has been already put by General Sir Richard Strachey, and I will quote his words:—

"To investigate and delineate the various features of the earth, to study the distribution of land and sea, and their effects upon climate, the configuration and relief of the surface, positions on the globe, and so forth, facts which determine the existent conditions of various parts of the earth, or which indicate former conditions, and to ascertain the relations that exist between those features and all that is observed on the earth."

Strabo, in the opening words of his introduction to his great Geography, puts it thus:—

"If the scientific investigation of any subject be the proper avocation of the philosopher, Geography, the science of which we propose to treat, is certainly entitled to a high place. In addition to its vast importance in regard to social life and the art of government, Geography unfolds to us the celestial phenomena, acquaints us with the occupants of the land and ocean, and the vegetation, fruits, and peculiarities of the various quarters of the earth."

This was written when Geography included all natural science, and before it gave birth to so many separate subjects; but it sets forth so admirably the aims which the geographer still pursues that it is worthy of remembrance.

It is not advocated, nor is it in any way necessary, that all should study Geography in the extended sense thus indicated; but it cannot be too strongly pointed out that an educated man—and education is now essential to the successful conduct of affairs—must have a considerable knowledge of the elementary facts of Geography.

These elementary facts are, it is true, of the nature of a lesson, and must be learnt, so to speak, by heart by the aid of maps and books; but this is nothing more than making use of the labours of others without which no advance is possible in any subject, and is common to all studies.

We must, in fact, distinguish between the science of Geography, which consists in ascertaining and coordinating new facts, and putting them into a shape for the use of others, which is the work of comparatively few; and the practical Geography which consists of making use of that work, and, as in many other branches of science, is within the reach of all who choose to devote time to it.

It is the object and business of the British Association to try to interest their fellow-countrymen in all branches of knowledge, to gain if possible more workers in science, but at any rate to induce all educated persons to take advantage of the solid work done by others towards the elucidation of the details of the glorious Nature which surrounds us on all sides, and in so many forms, and without which ignorance and superstition, those primary bars to the advancement of mankind, can never be banished.

It is impossible to have a clear comprehension of history, whether past or current, without calling in the aid of Geography; but unfortunately much history has been written and taught without such aid.

To read the daily paper requires either geographical knowledge or constant reference to maps; and if readers would only make a practice of such reference on every occasion when they are at fault, they would soon find themselves acquiring knowledge of the greatest use to them in the easiest and most interesting manner, and with the smallest expenditure of time.

The mistakes made even by those responsible for the conduct of public affairs, by reason of the want of this essential but elementary knowledge, are innumerable, and to this day there are many who consider themselves highly educated and capable men who cannot even rightly understand a map.

As I have before indicated, good maps are the foundation of all sound geographical knowledge, and these maps must be founded on good surveys.

Now a good survey is a comparatively modern operation, and the parts of the world that have been subjected to it are small indeed.

It is true that we now have general maps of the larger parts of the world, which more or less convey a fair representation of the configuration of land and sea when large areas are considered, but details are sadly lacking almost everywhere.

It is not astonishing, for to make the necessary surveys requires an enormous expenditure of both time and money, and the latter is hard to get until the necessity for its expenditure is patent to the smallest intelligence. Thus many countries long settled and in a high state of civilisation are still without any organised system of survey or maps, and even in the United Kingdom it is only from the year 1784 that a proper survey was established of the British Isles, though no maps were published from it until 1801; and it has proceeded so slowly that it has only recently been in one sense completed, while its revision, badly wanted on account of changes, is still in active prosecution, and must be continued *ad infinitum*.

Such indifference is, however, giving way to experience of the results of absence of proper maps, and all who wish well to the progress of South Africa must be pleased at finding that their provision has been taken in hand on such an admirably scientific basis as is provided by the Trigonometrical Survey, now far advanced, and the successful progress of which is, I believe, greatly due to the inexhaustible energy of my friend Sir David Gill, who seems to find time to promote and aid all branches of knowledge, and that steps are now being taken to prosecute the detailed topographical survey and provide good maps.

To many people one map is as good as another. They do not pause to consider on what it is based, or what degree of accuracy it probably possesses, but so long as there is a map they are satisfied.

A vast number of existing maps are compiled from the roughest materials: in partly occupied countries, from drawings of small areas placed together as can best be done, by means of places here and there, the relative positions of which are fairly known by distances along roads, with perhaps in some cases angles and astronomical positions; in less civilised parts by routes of travellers laid down by estimation of the distance traversed and direction of march, checked perhaps by a few astronomical observations of more or less value as the traveller possesses or does not possess the necessary skill.

The compilers of such a map have a difficult task. Discrepancies are, of course, multitudinous. Nothing agrees, and one has to accept, reject, and adjust as best he can on his own responsibility and with what knowledge he can procure of the respective trustworthiness of each author.

Happy is he if he has even a few positions in his map which have been properly determined, as between them he is saved from the constantly increasing errors of adding one little area to another, which if carried on indefinitely culminates in great errors.

Of course such maps are of no practical use, save as giving a very general idea of a country, and when required by the administrator or traveller lead to endless mistakes and annoyances.

The feature of our globe which is now, broadly speaking, most accurately laid down is the coast-line. The safety of navigation has caused general marine surveys to be carried on all over the world during the nineteenth century, which have finally determined the position and shape of the boundaries of the sea.

These surveys, executed for the most part by skilled naval officers with proper instrumental outfit, and supplied especially with trustworthy chronometers, and based upon frequent carefully determined astronomical positions, have resulted in this boundary line being delineated with an accuracy, so far as its absolute position is concerned, far in advance of any other main feature in maps.

Here I may perhaps explain to those unversed in these matters why this is so.

The position of any spot on the earth's surface can be ascertained in two ways: either by careful measurement by means of an accurate system of triangles from another spot already fixed, or by independent observations of the heavenly bodies and calculations from them, which give the precise latitude and longitude of the place. The former is suitable for positions inland, but entails much time and labour, and is only adopted when a perfect map is to be made, for which it is the indispensable foundation. The latter can be carried on from a ship, and in most circumstances only from a ship, because of the limitations of the methods of determinating longitudes.

Longitude can now be satisfactorily and rapidly ascertained in two ways: by the electric telegraph or by use of chronometers.

The places served by the electric telegraph are still few, and its use is therefore restricted; but the chronometer has been in working use for more than a hundred years.

This instrument, which is merely a watch of especial construction, will only keep a steady rate when it is undisturbed by irregular shocks or motions.

No means have yet been found for transporting a chronometer on land without upsetting its regularity, and therefore rendering it useless; but on board a ship it can be so suspended and stowed as to prevent its being disturbed by any ordinary movements of or in the ship. The accurate time of any place departed from, ascertained by astronomical observations, can therefore be carried about on board ship for considerable periods, and by comparison with the local time, also determined by sextant observations of the heavenly bodies, at any required spot on the coast, the difference of longitude is at once obtained with very small limits of error when a number of chronometers are employed. These two simple yet marvellous instruments, the sextant and the chronometer, have thus placed in the hands of sailors ready means of fixing with great exactitude and celerity the position of selected points on coasts all over the world; and it will be seen that, while the detail of the line of coast between such fixed positions will depend upon the degree of accuracy of the survey or sketch, the general line cannot get far out, as it is constantly checked at the selected points.

It is not claiming too much to say that at the present time very few salient points on the coast-lines of the world are as much as two miles in doubt.

It should be a source of great satisfaction to the Briton to know that both these instruments were devised by Englishmen, John Hadley producing the sextant in 1730, in the form still used, on the basis of ideas formulated by Newton fifty years before; and John Harrison the chronometer in 1736. The latter instrument has undergone modifications in detail, but the principle remains the same. It required seventy years before its value was fully recognised and it came into general use.

It is a still further satisfaction to think that it is British naval officers who have made by far the greatest use of them in mapping the coasts of the whole world. Since the time of the great Captain Cook British surveying vessels have been constantly employed in this work, not only in British colonies, but in all parts, aiding and often paving the way for British commerce, and for the men-of-war that protect it.

It is difficult to find coasts of any extent that have not been laid down by British marine surveyors. The whole of Africa has been their work. By far the greater part of America, all the south and east coasts of Asia, Australia, and most of the innumerable islands in all oceans have been fixed and laid down by them. Even in the Mediterranean, until very lately, the charts were mostly founded on British surveys, and the improvements now being carried out by other nations on their own coasts in details required for modern navigation do not materially modify the main shapes and positions formerly determined by the British.

It has been, and is, a great work, and I hope I may be pardoned for dwelling on it with pride as the result of the wise administration of the Admiralty for many years, and of the immediate labours of my predecessors as Hydrographer, and as a very great contribution to geographical knowledge, more especially as I do not think that it is generally realised that this great advance in geographic accuracy is due to marine surveyors.

To give an idea of the comparative accuracy of the chronometer method, I may mention that on taking at hazard eleven places distributed all over the world at great distances from England, the longitudes of which have been recently determined by means of the electric telegraph and elaborate series of observations, I find that the average difference between the chronometer and the telegraph positions is 700 yards. The shapes of the different continents and the positions of islands as at present on our maps and charts will never be altered except in insignificant degree, and the framework is ready for many years' work of land mapping.

It is not to be inferred from what I say that marine surveys are approaching their close. It is far otherwise. The time given to these enormous extents of coasts and seas, and the necessarily small scales on which the surveys have been carried on, have caused them to be very imperfect in all details. Hundreds of rocks and shoals, both stretching from the land and isolated in the sea, have been missed in the course of them, and loss of ships and life on these unknown dangers still continues. With the increase of shipping, increased number of ships of heavy draught, the closeness of navigation due to steam, and the desire to make quick passages, smaller inaccuracies of the charts become yearly of greater importance.

As an illustration of the condition of affairs I may mention that in Hamoaze, the inner harbour of Plymouth, one of the headquarters of the British fleet for more than 300 years, a small but dangerous pinnacle of rock was only discovered five years ago; whilst numerous other dangers of a similar character have been yearly revealed in close surveys of other harbours in the United Kingdom, supposed to be well examined and charted in the last century.

There never was a greater need for close marine surveys of places frequented by ships than now.

It is interesting to look back and see the gradual progress of the delineation of the world and to mark how very recent any approach to accuracy is.

The very earliest maps of any extent of country are unfortunately lost to us. The first man who made a map of which any historical record exists is Anaximander of Miletus, about 600 B.C., but we know nothing of it. A map is mentioned by Herodotus as having been taken in 500 B.C. by Aristagoras of Miletus in the shape of an engraved bronze plate whereon the whole circuit of the earth was engraved, with all its seas and rivers, to influence Cleomenes, King of Sparta, to aid the Ionians against Persia. This was probably the work of Hecatæus, to whom early Geography owed much. His works are also only known to us by quotation; but they are especially interesting as containing an early idea of the limits of Africa, which he

represents as entirely surrounded by the sea—a circumstance apparently either forgotten or disbelieved in later years.

Erotosthenes, 250 B.C., and Hipparchus, 150 B.C., made great advances, and the former made the first attempt to measure the size of the earth by the difference of latitudes between Assouan and Alexandria in Egypt, an attempt which, considering the great imperfection of his means, was remarkably successful, as, assuming that we are right in the length of the stadium he used, he made the circumference of the globe 25,000 geographical miles, whereas it should be 21,600.

He also devised the system of meridians and parallels as we now have them; but the terms "latitude" and "longitude," to denote positions on those circles, were introduced by Ptolemy.

The maps of Ptolemy, the great Alexandrian astronomer and geographer of A.D. 150, are the earliest we possess. He drew, besides a general map of the whole known world from the southern part of the Baltic to the Gulf of Guinea, north and south, and from the Canary Islands to the China Sea, east and west, a series of twenty-six maps of the different parts.

Ptolemy's maps and his method of representing the spherical globe on a flat surface had a great influence on Geography for many years. After his time the Greek civilisation waned, and the general decline of the Roman Empire, followed by its disruption by the invasion of barbarians, closed the course of discovery in all branches of research for centuries. It is not too much to say that for 1300 years no advance was made, and until the commencement of exploration by sea, which accompanied the general revival of learning in the fifteenth century, Ptolemy's maps represented the knowledge of the world.

As might be expected, the further he got from the Mediterranean, the greater were his errors; and his representations of Eastern Asia and North-Western Europe are somewhat grotesque, though quite recognisable in the main.

Of Africa south of the Equator he knows nothing, and his map of it terminates with the border.

This is somewhat remarkable, as I am one of those who firmly believe in the circumnavigation of Africa by the Phœnicians sent by Necho, King of Egypt, in 600 B.C. from the head of the Red Sea. As described by Herodotus, the voyage has all the impress of veracity. My personal faith in Herodotus was much strengthened by finding when I surveyed the Dardanelles in 1872 that his dimensions of that strait were nearer the truth than those of other and later authorities, even down to the time at which I was at work, as well as by other geographical tests I was able to apply. When, therefore, he records that the Phœnicians declared that in their voyage they had the sun on their right hand, and says he does not believe it, he registers an item of information which goes far to prove the story correct. Influenced by Hecatæus, who though surrounding Africa by the sea cut it far short of the Equator, Herodotus could not conceive that the travellers had passed to the south of the sun when it was in the southern tropic.

No historical incident has been more discussed than this voyage, commentators varying much in their opinions of its truth. But we have to-day some new facts. No one who has followed the exploration of the ancient buildings in Rhodesia, and considered the information we possess on the early inhabitants of Southern Arabia, whether we call them Sabæans or Himyarites, can doubt that the former were mainly the work of men coming from Arabia at a very early date, while the period of time necessary to carry out gold-mining operations over the large areas now found to have been exploited must have been very great.

It seems strange that no record of the constant voyages to this El Dorado should remain, but the very natural desire to keep lucrative information to themselves is not an unknown thing amongst traders of the present day, while the conditions of society and the absence of written records of South Arabia would make concealment easy.

The Phœnicians, an allied race, and the great seafaring trading nation of the Mediterranean, succeeded in keeping the majority of their marts secret, and we have incidents recorded showing their determination not to allow others to follow their steps, while to this day we are very doubtful of the limits of their voyages.

It may be considered certain that while we naturally quote Greek historians and geographers as the early authorities for the growth of geographical knowledge, and that the scientific basis for proper maps of large areas was really provided by them, the seafaring nations, Arabians, Phœnicians, and Chinese, knew a very great deal practically of the coasts of various parts of the Old World that were absolutely unknown to the Greeks.

The favourable conditions afforded by those remarkable periodic winds, the monsoons, would in the China Sea, Bay of Bengal, and the Arabian Sea naturally facilitate any attempts at extensive sea voyages, and would lead to such attempts under conditions that in the regions of variable winds would be considered too dangerous and uncertain. The fact that the monsoons in nearly every case blow practically parallel to the coasts in opposite directions is a most important factor in considering early navigation. The direction of the wind itself in such cases roughly guides a vessel without a compass, and the periods of cyclones and unsettled weather between the monsoons would soon be noted and avoided, as they are to this day by the Arabs and Chinese, whose vessels, I have very little doubt, have remained practically the same for thousands of years.

The unknown Greek author of that unique and most interesting document, the "Periplus of the Erythræan Sea," probably of the first century A.D., describes vessels built without nails, the planks of which were bound together by cords, in precisely the same way as many Arab dhows now navigating the Indian Ocean. His personal knowledge of Africa evidently ceased at Cape Guardafui, though he gives information gained from others on the East Coast as far as Zanzibar, which—or, rather, a part on the mainland near—he describes as the limit of trade to the south. We know that Arabs had penetrated further, but no doubt they kept their knowledge to themselves.

These early navigators very probably had charts. When Vasco da Gama first passed along the eastern coast of Africa he found that the Arab dhows had charts. Unfortunately none of them has come down to us, or it would have been interesting to compare them with those of the West Coast used by the Portuguese at the time, and which were of the crudest description.

I claim for sailors of all ages that they would be the first to make practical maps of the shape of the coasts. Their safety and convenience demanded it, while it is a far easier task to compile such a picture of the earth from successive voyages along coasts over the sea, where average distances from known rates of sailing and courses from the sun and stars can be more accurately ascertained, than from long and generally tortuous land journeys in directions governed by natural features, towns, and so forth. A navigator *must* be a bit of an astronomer. A landsman to this day seldom knows one star from another.

It was the sea-charts, or *portolani*, of the Middle Ages that on the revival of learning first gave respectable representations of the shape of the coasts, at a time when the learned monks and others were drawing the most fantastic and absurd pictures which they called maps.

At the same time it must be remembered that in all ages and down to the present day pilots, who within a hundred years were usually carried by all ships, even for sea voyages, jealously keep their knowledge largely in their heads, and look upon good charts as contrivances to destroy their profession, and that such charts or notes as they had they would keep religiously to their fraternity.

The Egyptians were no sailors, but we know that they habitually employed Phœnicians for sea expeditions, while we have the historical record of the Old Testament for their employment by David and Solomon for a like purpose in the Red Sea, and probably far to the south. It is, therefore, almost impossible to doubt that the Phœnicians were also acquainted with the navigation of the Red Sea and east coast of Africa. Such a voyage as that recorded by Herodotus would in these circumstances be far from improbable.

The varying monsoons which had led the Arabians centuries before to get so intimate a knowledge of the east coast as to enable them to find and work the goldfields would be well known to the Phœnicians, and the hardy seamen who braved the tempestuous regions lying between

Cadiz and Great Britain would make little of the difficulties of the African seas.

The limit of easy navigation from and to the Red Sea is Sofala. I do not think that it is too great a use of imagination to suppose that it would be from information received in what is now North Rhodesia that it was learnt that to the westward lay the sea again, and that this led to the attempt to reach it by the south.

Once started from the neighbourhood of Sofala, they would find themselves in that great oceanic stream, the Agulhas Current, which would carry them rapidly to the southern extremity of Africa.

I, as a sailor, can also even conceive that finding themselves in that strong current they would be alarmed and attempt to turn back, and that after struggling in vain against it they would have accepted the inevitable and gone with it, and that without the Agulhas Current no such complete voyage of circumnavigation would have been made.

As Major Rennell in the last century pointed out, once past the Cape of Good Hope, the periodic winds, and over a great part of their journey the currents, would help them up the West African coast; and the general conditions of navigation are favourable the whole way to the Straits of Gibraltar, the ships keeping, as they would do, near the land; but we can well understand that, as recorded, the voyage occupied nearly three years, and that they halted from time to time to sow and reap crops. I should say that it is highly probable that either Simon's Bay or Table Bay was selected as one of these stopping-places.

No reference to this voyage has been found amongst the hieroglyphic records, and, indeed, so far few such records of Necho, whose reign was not for long, are known; but that it was regarded at the time as historical is evident, for Xerxes, a hundred years later, sent an expedition to repeat it in the contrary direction.

This, however, failed, and the unfortunate leader, Sataspes, was impaled on his unsuccessful return.

This attempt shows that the greater difficulty of the circumnavigation from west to east, as compared with that from east to west, was not realised, and points to the concealment of any details of the successful voyage.

Of Hanno's voyage from the Straits of Gibraltar to about Sierra Leone, the date of which is uncertain, but from 500 to 600 B.C., we should know little had not good fortune preserved the record deposited in a Carthaginian temple.

But the well-known secrecy of the Phœnicians in all matters connected with their foreign trade and voyages would explain why so little was known of Necho's voyage, and our present knowledge of the extensive ancient gold workings of Rhodesia shows how much went on in those times of which we are wholly ignorant.

I have dwelt perhaps too long on this subject, but it has to me a great interest; and as it has not, so far as I know, been dealt with by a seaman who is personally well acquainted with the ways of seamen in sailing ships and with the navigation of the coasts in question, I hope I may be excused for putting my views on record.

There are several references in Greek and Latin historians to other circumnavigations, but none of them can be trusted, and apart from Necho's voyage we hear nothing of the east and south coasts of Africa until the arrival of the Portuguese at the end of the fifteenth century. But they found a thriving civilisation along the coast from Sofala northward, Shirazi, Arab, and Indian.

Ruins exist in many places which have not yet been properly investigated, and we are quite unable to say from what date we are to place the earliest foreign settlements, nor how many breaks existed in the continuity of the gold-mining, which apparently was proceeding at or very shortly before the Portuguese visit.

After the recommencement of exploration by sea in the fifteenth century, seamen slowly gathered enough information to draw the lines of the coasts they passed along, and in time—that is, by the middle of the eighteenth century—most lands were shown with approximately their right shapes. But of true accuracy there was none, for the reason I have before mentioned, that there was no exact method of obtaining longitude.

If we look at a general world chart of A.D. 1755—and to get the best of that period we must consult a French chart—we shall find on this small scale that the shape of the continents is fairly representative of the truth. But when we examine details we soon see how crude it all is.

I have compared with their true positions the positions of thirty-one of what may be taken as the fundamental points in the world as given in the larger scaled French charts of 1755, from which the general one is drawn, and I find that on an average they are forty-eight miles in error. The errors vary from 160 miles to two miles. If the delineation of the coast-lines between be considered the inaccuracies are very much greater.

Very shortly after this date more accurate determinations began to be made. The method of lunar distances was perfected and facilitated by tables published in the various astronomical "ephemerides," and seamen and explorers commenced to make use of it. Still the observation required constant practice, and the calculation, unless constantly made, was laborious, and it was used with complete success by the few. The great Captain Cook, who may be looked upon as the father of modern methods of surveying, did much to show the value of this method; but the chronometer came into use shortly after, and the principal advance in exact mapping was made by its aid, as I have already stated.

There is a vast amount yet to be done for Geography. Until we possess publications to which we can turn for full information on all geographical aspects of things on this globe of ours, there is work to be done. Seeing that our present publications are only now beginning to be worthy of being considered trustworthy for the very small amount of knowledge that we already possess, geographical work in all its branches is practically never-ending.

But of exploration pure and simple very little remains to be done. The charm of travelling through and describing an entirely new country which may be practically serviceable to civilised man has been taken from us by our predecessors, though limited regions still remain in Central Asia and South America of which we know little in detail.

I must except the Polar regions, which are in a somewhat special category, as their opening-up affords few attractions to many people. But a knowledge of the past history of our globe—fit study for human thought—can only be gained by study of the portions still under glacial conditions.

What is there round the South Pole—a continent or a group of large islands? What is going on there? What thickness does ice attain? Have these regions always been glaciated; and if not, why not? Can we get any nearer the mystery of magnetism and its constant changes by study at or near the magnetic poles? All these and many other scientific questions can only be solved by general geographical research in these regions, and all interested in such questions have been delighted at the recent attempts to gain more knowledge.

The object of these expeditions was frankly and purely scientific. All hope of remunerative whale or seal fisheries had been dispelled by the visit of the Norwegian whalers in 1892 to the region south of Cape Horn, and the known general condition of the land forbade any expectation of other profitable industries, unless indeed gold and other valuable minerals should be found, which is always possible. Beyond the fact that exploring expeditions of this character keep alive the spirit of enterprise and bring out the finest characteristics of a race—which is a point by no means to be despised—no immediate practical benefit was to be expected.

Progress under the conditions must be slow, but I think that Great Britain may well be satisfied with the information collected in the Antarctic by Captain R. F. Scott and his gallant companions. The unfortunate detention of the *Discovery* by an unfavourable summer prevented the further coastal exploration which was part of the programme, but gave opportunity for further detailed examination of the inland conditions, which was carried out in defiance of the severest atmospheric and topographical difficulties, and with the greatest zeal and intelligence; and it may be doubted whether Science in the end has not

gained more than she lost by the unexpected diversion of energy. The healthy conditions which prevailed throughout are a standing proof both of Captain Scott's eminent capacity as a leader and of the cheery spirit which animated the whole expedition.

The full results of the scientific observations are not yet worked out, and in many cases for a complete appreciation of their bearing they must be compared and correlated with those of the other Antarctic expeditions, but many highly suggestive points have already been revealed.

For the first time Antarctic continental land has been travelled over for long distances, and though the actual area of new discovery looks small on a map of the world, the distances covered can only be described as extraordinary, and far exceeding the most sanguine anticipations.

Few who considered the mountainous coast-line of Victoria Land and its complete glaciation, as reported by Sir James Ross from his distant view, thought that it would prove practicable not only to ascend those mountains, but to reach to heights much surpassing them behind.

The reason that it proved feasible is that, while there are occasional heavy snowstorms, the annual snowfall is small, and the surface, therefore, is generally unencumbered with soft deep snow.

And what did Captain Scott find after his memorable struggle up the glacier through the mountains?

An enormous plateau at an elevation of about 9000 feet, nearly level, smooth, and featureless, over which he travelled directly inland for more than 200 miles, seeing no sign at his furthest point of any termination or alteration in character. So far as could be seen from other journeys, glacial discharge from this great ice-sheet is very small, and practically it appears to be dead. Its accretion by fresh snowfall is insignificant, while on all sides along the flanks of the coastal mountains there are signs of diminution in the mass of ice.

The great ice-barrier east of Ross Island tells the same tale. This magnificent feature presents to the sea a face of perpendicular ice-cliffs varying from 60 to 240 feet in height and 450 sea-miles long. Sir J. Ross mapped its position in 1841, and Captain Scott finds that it has retreated on an average fifteen miles, varying much in different parts.

Should this rate of retreat continue the whole of this ice mass, so far as Captain Scott saw it, will have vanished in 1000 years.

As the motion of the ice mass is also about fifteen miles to the north in the same time, icebergs covering collectively an area of 450 miles by 30 have been discharged from it in sixty years.

Captain Scott travelled over it nearly due south to a point 300 miles from its face, and then saw no sign of its end.

It is bordered on its western side by a mountainous coastline, rising in places to 15,000 feet He found the ice practically flat and wholly unfissured, except at the side, where its northerly motion, found to be about 130 feet in the month, caused shearing and vast crevasses. All that is known of its eastern edge is that it is bordered, where it meets the sea, by land from 2000 to 3000 feet high, suspected by Ross and verified by Captain Scott. This may be an island, or more probably the eastern side of the great fiord or bay now filled by the barrier.

Captain Scott is of opinion that this great ice-sheet is afloat throughout, and I entirely agree with this conclusion. It is unexpected, but everything points to it.

From soundings obtained along the face it undoubtedly has about 600 feet of water under it.

It is difficult to believe that this enormous weight of ice, 450 miles by at least 360, and perhaps very much more, with no fall to help it along by gravity, can have behind it a sufficient force in true land glacier to overcome the stupendous friction and put it in motion if it be resting on the bottom. It is sufficiently astonishing that there is force enough even to overcome the cohesion at the side, which must be very great.

The flat nature of the bottom of the Ross Sea and the analogies of many geographical details in other parts of the world make it most probable that the water under the whole barrier is deep.

A point on which I have seen no comment is the difference in the appearance of the slopes of Mount Terror. Captain Scott found the bare land showing over large areas, but during the two summers of Ross's visit it was wholly snow-clad. Sir Joseph Hooker, the sole survivor of Ross's expedition, when questioned had no doubt on the subject, and produced many sketches in support.

This may be due to temporary causes, but all the information collected by the expedition points without doubt to steadily diminishing glaciation in recent times. We have, therefore, this interesting fact, that both in Arctic and Antarctic regions, as indeed all over the world, ice conditions are simultaneously ameliorating, and theories of alternate northern and southern maximum glaciations seem so far disproved.

But this does not mean that climatic conditions in the Antarctic are now less severe—probably the contrary. It has been pointed out by many that land glaciation may arise from varied primary causes, but one obvious necessity is that the snowfall should exceed melting and evaporation. It need not be heavy; but if it is, it may produce glaciation under somewhat unexpected conditions. This would entail a vapour-laden air more or less continuously impinging upon the land at a temperature which will enable it when cooled, either by passing over chilled land or when raised to higher regions by the interposition of mountains, to give up its moisture freely. This condition is not fulfilled when the air as it arrives from the sea is already at a very low temperature.

It was my fortune to spend two long seasons in the Straits of Magellan, and I was daily more impressed by what I saw.

There you have a mountainous ridge of no great height—very few peaks rising more than 4000 feet—opposed to the almost continuous westerly winds pouring in from the Pacific at a very moderate temperature and charged with much moisture.

The result is that in the latitude of Yorkshire every mountain mass over 3000 feet high is covered with eternal snow, and sends glaciers down to the sea.

I was convinced by what was going on under my eyes that it only required an upheaval of the land of 2000 feet or so to cover the whole of Patagonia with ice. But then the climate would still not be very severe. The temperature of the wind from the sea would be the same, and such part of it as blew along the channels and on the lower land would moderate the cold caused by the ice-covered slopes.

The shores of the whole of Western Southern Patagonia, deeply indented with long and deep fiords, indicate, according to all received views of the origin of such formations, that the land was formerly higher, while signs of glaciation are everywhere present.

The results of geographical research show us that in many parts of the world climate must have greatly changed in comparatively recent times.

In the now arid regions of Northern Africa, Central North America, and in parts of Asia there is ample evidence that the climate was in times past more humid. In a remarkable paper on the causes of changes of climate, contributed by Mr. F. W. Harmer to the Geological Society in 1901, and which has not obtained the notice it deserves, it is pointed out how changes in the distribution of the prevalent winds would vastly alter climatic conditions. Like everything else in Nature, and especially in the department of meteorology, these questions are exceedingly complex, and similar results may be brought about in different ways, but there can be no doubt that the climate of South Africa would be greatly modified, and more rainfall would occur, if only the cyclonic storms which now chase each other to the eastward in the ocean south of the Cape of Good Hope could be prevailed upon to pursue a slightly more northerly line, and many obstacles to the agricultural prospects of South Africa now existing would be removed. This is, however, beyond the powers of man to effect; but, as I have just said, there are other ways of attaining the object, and it is earnestly to be hoped that the attention now being paid to afforestation may result in vigorous efforts to bring about by this means the improvement in humidity so much required in many parts of the country.

The other recent event in geographical exploration is the result of the expedition to Lhasa. It was an unexpected solution of this long-desired knowledge that it should come from political necessities and by means of a Government mission. The many ardent travellers who have dreamed of one day making their way in by stealth have thus been disappointed, but our knowledge is now fuller than could otherwise have been gathered.

The most important fact is the revelation of the fertility of a large part of Southern Tibet. Much has been added to topographical knowledge, but the route maps of the secret Indian native surveyors already had given us a rough knowledge of the country on the road to Lhasa. It was not, however, realised how great was the difference between the aridity of the vast regions of the north, known to us from the travels of men of various nationalities, and the better-watered area in the south, though from the great height of the plateau—some 12,000 feet—the climate is very severe. The upper course of the Brahmaputra has been traced by Captain Ryder, but, unfortunately, a political veto was placed on the project to solve the interesting problem of how this great river finds its way to the Indian plains, and this still remains for the future to unravel.

Of the ocean, which has been my own particular study for many years, and on which alone I feel any special qualification to speak, I have said but little, for the reason that when presiding over this Section on a former occasion I took it for my theme, but there are a few points regarding it which I should like to bring to your notice.

It is of the ocean, more than of any other physical feature of our globe, that our knowledge has increased of late years. Forty years ago we were profoundly ignorant even of its depth, with the exception of a few lines of soundings then recently taken for the first submarine telegraph cables, and consequently we knew nothing of its real vast bulk. As to the life in it, and the laws which govern the distribution of such life, we were similarly ignorant, as of many other details.

The *Challenger* expedition changed all this, and gave an impetus to oceanographic research which has in the hands of all nations borne much fruit.

Soundings have been obtained over all parts of the seas, even in the two polar seas; and though much remains to be done, we can now form a very close approximation to the amount of water on our earth, whilst the term "unfathomable ocean" has been shown to have been based on an entire misconception. Biological research has also revealed a whole world of living forms at all depths of the existence of which nothing was known before.

In my former Address, eleven years ago, I gave many details about the sea, of which I will only repeat one—which is a fact that everyone should know—and that is, that the bulk of the ocean is about fourteen times as great as that of the dry land above water, and that if the whole of that land were thrown into the Atlantic Ocean it would only fill one-third of it.

Eleven years ago the greatest depth known was 4700 fathoms, or 28,000 feet. We have since found several places in the Pacific where the depth is nearly 5170 fathoms, or 31,000 feet, or somewhat higher than Mount Everest, which has been lately definitely shown to be the culminating point of the Himalayas. These very deep parts of the ocean are invariably near land, and are apparently in the shape of troughs, and are probably due to the original crumpling of the earth's surface under slow contraction.

The enormous area of the sea has a great effect upon climate, but not so much in the direct way formerly believed. While a mass of warm or cold water off a coast must to some extent modify temperature, a greater direct cause is the winds, which, however, are in many parts the effect of the distribution of warm and cold water in the ocean perhaps thousands of miles away. Take the United Kingdom, notoriously warm and damp for its position in latitude. This is due mainly to the prevalence of westerly winds. These winds, again, are part of cyclonic systems principally engendered off the coasts of Eastern North America and Newfoundland, where hot and cold sea-currents, impinging on one another, give rise to great variations of temperature and movements of the atmosphere which start cyclonic systems travelling eastwards.

The centre of the majority of these systems passes north of Great Britain. Hence the warm and damp parts of them strike the country with westerly winds, which have also pushed the warm water left by the dying-out current of the Gulf Stream off Newfoundland across the Atlantic, and raises the temperature of the sea off Britain.

When the cyclonic systems pass south of England, as they occasionally do, cold north-east and north winds are the result, chilling the country despite the warm water surrounding the islands.

It only requires a rearrangement of the direction of the main Atlantic currents wholly to change the climate of Western Europe. Such an arrangement would be effected by the submergence of the Isthmus of Panama and adjacent country, allowing the Equatorial Current to pass into the Pacific. The gale factory of the Western Atlantic would then be greatly reduced.

The area south of the Cape of Good Hope is another birthplace of great cyclonic systems, the warm Agulhas Current meeting colder water moving up from the Polar regions; but in the Southern Ocean the conditions of the distribution of land are different, and these systems sweep round and round the world, only catching and affecting the south part of Tasmania, New Zealand, and Patagonia.

In 1894 I spoke of the movements of the lower strata of water in the sea as a subject on which we were only beginning to get a little light. Since that year we have learnt a little more. It is a common idea that at the bottom of the sea all is still; but this is a mistake, even for the deepest parts, for the tidal influence reaches to the bottom and keeps every particle in motion, though such motion is quiet and slow.

Near the shore, however, though still in deep water, the movement may be considerably increased. Cases have occurred in late years where submarine cables have broken several hundred fathoms deep, and when picked up for repair it has been found that the iron wire covering has been literally rubbed away as by a file. This can only be the result of an undercurrent along the bottom moving the cable to and fro. Such a current might be caused by a submarine spring, for there is no doubt that much fresh water finds its way into the ocean in this fashion, but it is more probably generally an effect of acceleration of the tidal movement due to the rising slope of the continent.

In connection with this, further facts have come to light in the course of recent marine surveys.

Many isolated shoal spots in the great oceans have figured in our charts, the results of reports by passing sailors who have said they have seen breakers in fine weather.

Such places are the terror of seamen, and it is part of the duty of surveying ships to verify or disprove them. Very much has been done in the last eighteen years, with the result that the majority of them have, as dangers, disappeared. In many cases, however, a bank has been found, deep in the ordinary acceptation of the word, but must less deep than the surrounding sea—solitary ridges, in fact, rising from the ocean floor. Frequently, in examining these banks in search of shoaler spots, breakers have been reported and recognised as such on board the surveying ship from a distance, but on approach they have proved to be small overcurls caused by tide ripplings, and the depth of water has proved to be several hundred fathoms. These ripplings are clearly caused by the small tidal motion in the deep water, generally in these cases of more than 2000 fathoms, meeting the slope of the submerged mountain range, being concentrated and accelerated until the water finally flows up the top of the slope as a definite current, and taking the line of least resistance, that to the surface, makes itself visible in the shape which we are accustomed to associate with comparatively shallow water.

These cases form remarkable instances of the manner in which extensive motion of water may arise from very small beginnings.

An observation I was anxious to make in 1894 has been successfully carried out since. This was to ascertain whether there was any permanent undercurrent in the Straits of Bab-el-Mandeb due to more water being forced through the strait on the surface by the persistent S.E. wind of winter than could be evaporated in the closed Red Sea.

Such return undercurrents have in somewhat similar circumstances been shown to exist in the Dardanelles, Strait of Gibraltar, and in the Suez Canal.

The observation at Bab-el-Mandeb was difficult. The wind is strong and the disturbance of the sea is considerable, while the water is 120 fathoms or 700 feet deep. But a surveying vessel maintained herself at anchor there during four days, and, by the aid of an ingenious apparatus sent from England for the purpose, clearly proved the existence of a current of 1½ knot flowing steadily at depths below 70 fathoms out of the Red Sea, whilst in the upper strata there was a similar current flowing in. In such ways is interchange of water provided for by Nature in places where tidal action does not suffice.

In what I fear is a very discursive Address I have not mentioned the interior of Africa. In the first place, it is a subject of itself; and as we shall have, I hope, many papers on African subjects I have thought it better to deal mainly with generalities.

Still I cannot refrain from a few words to express the astonishment I always feel when I hear people complain that Africa goes slow. When I look at what has been effected in my own lifetime, it appears to me that, on the contrary, it has been rushed. The maps I learnt from as a boy showed the whole interior as a blank. There are now no parts that are not more or less known. The great lakes have all been revealed; the great rivers have all been traced; Europeans are now firmly fixed with decent governments in parts formerly a prey to tribal wars and the atrocities of the inland slave traffic. Railways are running over regions unknown forty years ago, and one of the most astonishing things to me is that I should be able to hope now to visit in comfort and luxury the great Victoria Falls which my old friend Sir John Kirk—whom I left the other day hale and hearty—was, with the exception of Livingstone, the first white man to see, after a long and laborious journey in his company in 1860.

I could not help being amused as well as interested at seeing a short time ago a proclamation by the Government of Northern Rhodesia, dated not far from Lake Bangweolo, calling on all concerned to observe neutrality during the present war between Russia and Japan. I think that if anyone had prophesied to Livingstone, as he lay in 1873 lonely and dying by the shores of that newly discovered lake, that such an edict would be issued in thirty years he would have expressed a doubt as to its fulfilment.

To Southern Africa Nature has denied two of the features that facilitate rapid progress—good harbours and sufficient rainfall—but the energy of man has done wonders to provide the former where possible, and will doubtless do more; whilst I believe that the lack of the latter will also be overcome in the same way. The coordinated—or, in other words, the scientific—observations made in many other countries have pointed out a possible solution. On the other hand, the height of the inland plateaux makes it possible for the white man to live and work in latitudes which would under other conditions be tropical.

South Africa must have a great future before it; and while some present circumstances may delay development of its natural advantages, I am inclined to think that in the long run prosperity may be more solid and material for being reached in the face of difficulties, as has so often occurred in the history of the world.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 21.—M. Bouquet de la Grye in the chair.—On the laws of sliding friction: Paul **Painlevé**. A discussion of a problem suggested by M. de Sparre in a recent paper, and of the conditions necessary for a solution without ambiguity.—The cause of the presence of abnormal quantities of starch in bruised apples: G. **Warcollier**. It is shown that tannin from galls prevents all action of amylase on starch, and it is supposed that the accumulation of starch in bruised apples is due to a similar action.

CALCUTTA.

Asiatic Society of Bengal, August 2.—Additions to the collection of Oriental snakes in the Indian Museum, part iii.: N. **Annandale**. Four new species and a new genus are described, two of the former coming from the Malay Archipelago, one from N.E. India, and one from Gilgit. Notes on other species from different parts of the Oriental region are given. This paper completes the series for the present, the collection now being worked out and arranged.—Sal-ammoniac: a study in primitive chemistry: H. E. **Stapleton**. An attempt to carry back the history of sal-ammoniac through Mohammedan times, and to throw light on the primitive conceptions of nature which led to its introduction as an alchemical drug. Although little used by the Greek school of Alexandria, it was in high repute as one of the alchemical "stones" of the Arabs, and through their agency the substance passed into European alchemy. Authorities are given for the belief that the salt owed its reputation partly to its magical qualities, which were due to its connection with human hair and other animal substances, and partly to its strictly chemical qualities. A suggestion is finally made that the salt was originally introduced into Western Asia through Persia from China.—Alchemical equipment in the eleventh century, A.D.: H. E. **Stapleton** and R. F. **Azo**. This paper is an annotated analysis of an Arabic treatise on alchemy lately discovered in the library of His Highness the Nawab of Rampur. The treatise was written in Baghdad in the year 426 A.H. (1034 A.D.), and though now in a somewhat mutilated state, it affords a welcome addition to our knowledge of alchemical methods and equipment in the eleventh century. Special attention is directed to (1) the great importance attached to weights in chemical operations 700 years before the time of Black and Lavoisier; and (2) the drawings and description of the *Vthāl* (Aludel), which furnish, for the first time from Arabic sources, a clear conception of this instrument.

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THURSDAY, SEPTEMBER 7, 1905.

MARINE ENGINEERING.

Marine Engines and Boilers, their Design and Construction. Based on the work by Dr. G. Bauer. Translated from the second German edition by E. M. and S. Bryan Donkin. Edited by Leslie S. Robertson. Pp. xxviii+744. (London: Crosby Lockwood and Son.) Price 25s. net.

THIS considerable work fills a gap in English engineering literature. For while the related subject of naval architecture has been treated by writers of authority, there is no very good modern book on marine engineering. Dr. Bauer states that it is intended to be a condensed treatise, embodying the theoretical and practical rules used in designing marine engines and boilers. But though thus limited in scope, it treats only of the most modern types and excludes even modern engines and boilers of special types. As might be expected from the engineer-in-chief of the Vulcan Works at Stettin, the machinery of warships and of some of the great German Atlantic liners are very fully illustrated. There is not a great deal of theoretical investigation, but what there is bears very definitely on design, and is sound so far as it goes. Perhaps the most valuable part of the book is the great amount of tabulated information about the proportions of the machinery in good examples of modern practice. There is also a very large collection of those empirical or semi-empirical rules, based on extensive practical experience, on which engineers necessarily so much rely. There is reason to be grateful that an engineer so distinguished as Dr. Bauer, with the care of a great factory on his shoulders, should have found time to produce such a systematic treatise, and that he has been able to obtain the aid of some of his principal technical assistants in dealing with parts of the subject.

The book has been excellently and competently translated, and the translators have undertaken the necessary, but very laborious, task of converting the numerical statements of formulæ from the metric to English measures. However bad our English system of measures may be, English engineers can only think and work in English measures, and the translation would have lost very much of its usefulness if the conversion had not been made. Mr. Leslie S. Robertson, who has edited the volume, has had practical experience in this branch of engineering, and has already published valuable works relating to it. His name is a guarantee that the adaptation of the work for English readers has been, from the technical point of view, thoroughly well done.

The general arrangement of the book is convenient. Part i., which occupies four-tenths of the volume, deals with the main engines. First, indicator diagrams are discussed, and the application of theoretical diagrams in settling cylinder proportions. The well known method of constructing theoretical diagrams from a diagram of the volumes occupied by the steam is given, and an example worked out. The remark is made that "the diagrams so obtained show the characteristics of actual diagrams, but their mean pressures are naturally much higher than they would be in actual practice." That is not our experience. If the data are rightly used, there is a fairly close approximation between the theoretical and actual mean pressures. It is a case in which the precise law of expansion assumed does not very much affect the result. There is one other small point in this chapter. The ratio of an actual to a theoretical diagram is called an "efficiency" (p. 17). This leads to the awkward statement on p. 35 that "the efficiency of triple expansion engines is less than that of single cylinder engines." If the more usual term "diagram factor" had been used instead of efficiency the statement would be less misleading.

Next there is a very short section dealing with some thermal circumstances affecting the utilisation of steam. This is too brief to be satisfactory, even from the point of view of engine design. For instance, the loss due to cylinder condensation is explained by saying that "heat is withdrawn from the steam at high pressure and restored to it at a lower pressure" (p. 37). The essential point that the heat is chiefly restored during exhaust is not mentioned. So the economy of multiple expansion engines is traced to reduction of temperature range. But the re-evaporation during exhaust from one cylinder increases the work in the next. In other respects also the explanation is deficient. However, the thermodynamics of steam engines is fully given in other treatises. An important section follows, in which the stroke, speed, and turning moment are discussed. The theory of torsional vibrations is given, and practical methods of determining the critical speed at which liability to strong torsional vibrations occurs. In connection with this there is a brief but clear and practical treatment of the problem of balancing. Then the arrangement of main engines is explained, and there is a long section dealing with the proportions of engine details and including a sufficient account of valve diagrams.

Part ii. deals with pumps. Part iii. discusses shafting, and in connection with this ship resistance, and the proportioning of propellers. German writers are adepts at tabulating coefficients and data, and the tables in this section are excellent. Part iv. is on pipes and connections. Part v. deals with steam boilers, and is chiefly descriptive of modern types. Here again the tabulated data from actual cases is information of the most useful kind, and the rules of the classification societies, which leave the engineer very little discretion, are fully given. The last section gives some account, rather too much condensed, of instruments used in steam engine and boiler trials. To many readers an account of Fottinger's torsion indicator for measuring the effective horse-power of engines by observing the torsion of the screw shaft will be interesting. Hirn first used a torsion dynamometer of this kind. As a diagram of the torsion angle is obtained, the variation of the power transmitted can be determined.

No account is given of the most recent change in marine engineering, namely, the adoption of the steam turbine in place of reciprocating engines. The success of the steam turbine in this field is already so well assured that a revolution in marine engineering is promised. But there are, no doubt, good reasons for the omission. Experience in the use of steam turbines in ships is almost confined to this country, and naturally at present full information as to the results, mechanical and economic, of the use of turbines is only possessed by a few engineers, and is not generally available.

In this country we still rightly pride ourselves on retaining the highest position in shipbuilding and marine engineering. But, if we still do more work of this kind than any other nation, and if our best work is as good as any in the world, yet Dr. Bauer's book should remind us that in science, experience and skill, other nations now run us very close.

THE BIRDS OF ICELAND.

Beitrag zur Kenntnis der Vogelwelt Islands. By B. Hantzsch. Pp. vi + 341; illustrated. (Berlin: Friedländer and Son, 1905.) Price 12 marks.

SINCE Iceland lies on one of the main migration routes, namely, that which starts from Greenland and Iceland itself, and passes by the Færöes to the British Islands, its bird-fauna is naturally of special interest and importance. This is testified by the appearance within a comparatively short period of two works on the subject, namely, Mr. H. N. Slater's "Manual of the Birds of Iceland," published at Edinburgh in 1901, and the present larger and more pretentious volume. In addition to the general fauna, there is special interest attaching to Iceland as the chief European resort in former days of the gare-fowl, or great auk. The history of this lost bird and the literature relating to it the author reserves for a supplemental volume. Despite all that has been done by travellers and collectors, Mr. Hantzsch is of opinion that our knowledge of the bird-fauna of Iceland is still far from complete, much of the interior of the country being difficult of access and still imperfectly explored by collectors. Accordingly he is fain to admit that the last word on the subject still remains to be said.

The volume commences with an historical survey of the growth of our knowledge of Icelandic ornithology, with notices of the chief explorers and workers in this field of research, and a list of the more important memoirs and books treating of the subject. Then comes a detailed account of the author's own journeys in the island for the purpose of collecting specimens and personally observing the birds. This is followed by an interesting description of the main physical features of Iceland and the neighbouring islets, such as Grimsey in the north and the Westman group in the south, this being illustrated with a number of reproductions of photographs of the scenery taken by the author himself. Special lists are given of the birds of Grimsey and the Westman Islands. Changes in the bird-fauna of the whole group of islands, and the general relationships of the fauna form the subjects of two succeeding chapters, a brief note being appended on domesticated species.

This completes the introductory portion of the subject, which occupies ninety-two pages, and the remainder of the text is devoted to the detailed synopsis of the birds. The total number of species, exclusive of the great auk, recorded in the preliminary list as definitely known to occur in Iceland is 120, in addition to which are a few of which the right to a place among the fauna is somewhat uncertain. Perhaps the most striking feature of the descriptive part of the work is the almost painful severity with which new fashions in ornithological nomenclature are followed, such appalling alliterations as *Merula merula merula* and *Gallinago gallinago gallinago* occurring with wearisome frequency. Without reiterating his own private opinion on nomenclature of this nature, which is now pretty well known, the reviewer may point out that when the typical form of a species is alone recorded, it is perfectly superfluous to add the terminal trinomial, *Merula merula* and *Gallinago gallinago* being in such cases apparently all that can possibly be required.

Excellent photographs of the eggs, nests, or breeding-haunts of some of the rarer species serve to enliven the text, and ornithologists will be greatly interested in the two pictures of the eggs and callow young of the great skua in their natural surroundings. The work will doubtless long remain the standard authority on Icelandic birds, at all events for German readers.

R. L.

OUR BOOK SHELF.

Neue Fische und Reptilien aus der böhmischen Kreideformation. By Prof. Dr. Anton Fritsch and Dr. Fr. Bayer. Pp. 34; plates ix. (Prague: Fr. Rivnac, 1905.)

VERTEBRATE fossils are not only rare, but also badly preserved, in the Cretaceous rocks of Bohemia. Palæontologists must therefore admire the enthusiasm of Dr. Anton Fritsch, who continues to devote to the interpretation of difficult fragments so much study as is evidenced by his numerous writings on these remains. In 1878 he published a complete synopsis of the subject as then understood. Now, with the aid of Dr. Franz Bayer in the determination of fishes, he again publishes an up-to-date treatise, including the discoveries of the last quarter of a century. The work is illustrated in Dr. Fritsch's usual style, and a few of the figures are revised drawings of specimens previously described.

Dr. Bayer's chapter on the Cretaceous fishes was originally published in the Bohemian language in 1902, but is now made more readily accessible in German. He describes evidence of several new genera and species, and concludes that in the Bohemian Chalk there are more varied representatives of the higher fishes than have hitherto been found below the Tertiary formations. In view of the fragmentary nature of most of the fossils, it must be

admitted that this conclusion needs confirmation from future discoveries before it can be definitely accepted. The specimens on which the new genera Coryphænopsis and Bayeria (Fritsch) are founded are certainly remarkable.

Dr. Fritsch's section of the work shows that all the usual groups of Cretaceous Reptilia are represented in the Bohemian rocks. There are undoubted fragments of Plesiosaurs, and there is one interesting brain-cast which the author describes as probably referable to Polyptychodon. Dr. Fritsch, however, overlooks the fact that the skull of Polyptychodon is actually known in England, and is undoubtedly Plesiosaurian or Pliosaurian, not Mosasaurian. Chelonian remains occur, evidently representing turtles related to the small *Chelone Benstedi* from the English Chalk. Some fragments appear to be Mosasaurian, but those described under the new name of *Iserosaurus litoralis* are extremely problematical. Other fragments, ascribed without much reason to Dinosauria, scarcely suffice to justify the new names bestowed on them. Some good new figures of the interesting wing-bones of the small Pterodactyl, *Ornithocheirus hlavaci*, are given, and the volume concludes with a systematic list of species.

A. S. W.

Die Bedeutung des Experimentes für den Unterricht in der Chemie. By Dr. Max Wehner. Pp. 62. (Leipzig and Berlin: B. G. Teubner, 1905.) Price 1.40 marks.

THIS brochure forms part of a "Sammlung naturwissenschaftlich-pädogogischer Abhandlungen," and is very hard reading for an ordinary English chemist. It is divided into two parts, the first of which deals with the importance of experiment for attaining the object of chemical instruction, and the second with the importance of experiment in relation to method in chemical instruction. It is hard reading in the sense that one has to wade through detailed arguments which culminate in conclusions such as "description does not suffice for the instruction of the pupil in chemical processes," and "the development of the laws concerning chemical processes from experimental observations is more effective for chemical teaching than their deduction from quoted examples." The work is, in fact, an example of pure pedagogical exercitation, and it may be recommended with confidence only to those who have a liking for that kind of literature.

A. S.

Monographie des Cynipides d'Europe et d'Algérie. By l'Abbé J. J. Kieffer. Tome second. 2me. fascicule. Pp. 289–748; plates ix–xxi. (Paris: A. Hermann.) Price 18s.

THIS is the conclusion of vol. vii. *bis* of André's great series of monographs, "Spécies des Hymenoptères," and completes the Cynipides, or gall flies. The previous portions have already been noticed in NATURE (vol. lxvii. pp. 124–5, December 11, 1902, and vol lxviii. p. 221, July 9, 1903), and the part now published completes the Cynipides, 5e tribu, Figitinæ; and also includes the Evaniides (divided into two tribes, Evaniinæ and Gasteruptioninæ), the Stephanides, Trigonalides, Agriotypides, general supplements, a "Catalogue méthodique et synonymique," extending from pp. 653 to 741 (double columns), and general indices.

The plan of the work is uniform throughout, and as the previous portions have already been discussed at considerable length, an extended notice is here unnecessary.

W. F. K.

The Gum-Bichromate Process. By J. Cruwys Richards. Pp. 119. (London: Iliffe and Sons, Ltd., n.d.) Price 2s. 6d. net.

THIS process of photographic printing is about fifty years old, but it is only during the last ten years or so that it has been adopted for practical purposes. When first introduced it was deliberately rejected, because it was not equal to the then known processes in reproducing the detail of the negative; latterly it has been taken up and very much appreciated by some of those who desire to be able to alter or "control" their photographic printing, and so obtain results that, while they can lay no claim to mechanical accuracy, more nearly please the æsthetic taste of the worker. At the present time there are more methods of photographic printing than there were a generation ago that are excellently adapted for the purposes of photography pure and simple; therefore the gum-bichromate process is still more than it was then a process for the specialist in the direction named. The author of this volume is well known as a successful worker of the method. He gives his own formulæ, and states clearly the practical details that he prefers to follow, but he also describes the methods of others. He is a warm advocate of "multiple printing"; that is, after coating the paper, exposing, developing with warm water aided with a brush or by other mechanical means, coating, exposing, and developing a second or even a third or more times, so gradually building up the picture with the maximum opportunity of "control." It will be obvious that every possibility of improvement in the hands of the skilful is a probability of error in the hands of the artistically ignorant, and that the process does not claim attention from a photographic point of view at all, but as enabling an artist to express his ideas with less trouble and perhaps with more accurate drawing than if he worked wholly by hand. The volume includes several reproductions of the author's works, some of them showing the print in its various stages of evolution.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Recent Changes in Vesuvius.

I BEG to enclose a somewhat free translation of a letter I have recently received from Prof. G. Mercalli, of Naples, concerning certain changes which have taken place in Vesuvius this year. During a visit to the mountain on August 14–16, I was able to approach quite near to the sources of the lava streams described by him, and also to examine the remarkable tunnels formed at certain places by the cooled surface of lava streams which had subsequently diminished in volume, or had even "run dry."

During the week preceding my visit, many incandescent bombs of pasty rock had been ejected from the crater at the summit, mostly in the direction of the side facing Pompeii, and these successively rolling down the ash-slope presented a beautiful spectacle at times. The lava streams proper often presented that curious double appearance, due to the fact that the colder and darker scoriæ, floating down the stream, keep to the more swiftly-moving current in mid-stream, and avoid the sides.

Yesternight (August 20) but one of the lava streams referred to by Prof. Mercalli was visible from Naples, the other having apparently ceased.

The explosions of Stromboli are occurring at intervals of about $3\frac{1}{2}$ minutes.

R. T. GÜNTHER.

R.M.S. *Oroya*, off Stromboli, August 21.

Lava Stream of May 27, 1905.

IN the months of April and May of this year Vesuvius began to show an increased activity, and in the crater, which was about 80 metres in depth, a small cone began to form; it increased rapidly, and by the middle of May had risen to a height of about 15 metres above the level of the enclosing crater.

From May 25 to May 27 violent explosions occurred, which were heard in all the villages on the mountain-side,

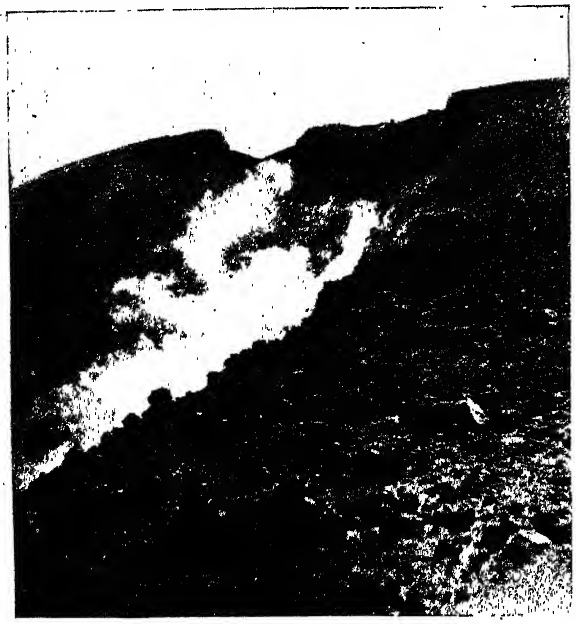

FIG. 1.—Source of lava stream of August 26, 1903. From a photograph by Prof. G. Mercalli, taken April 15, 1904.

and were accompanied by the ejection of much red-hot and liquid matter. These explosions ceased almost suddenly on the evening of May 27, and at about 6.45, a small lateral outlet, "A," burst through the north-west flank of the great cone at a height of about 1245 metres, and at the point where a seam in the mountain-side showed where the traces of the last eruption of August 26, 1903, still lingered.

A few hours after the first, a second outlet was formed, then a third, "B," both lower down, at an altitude of

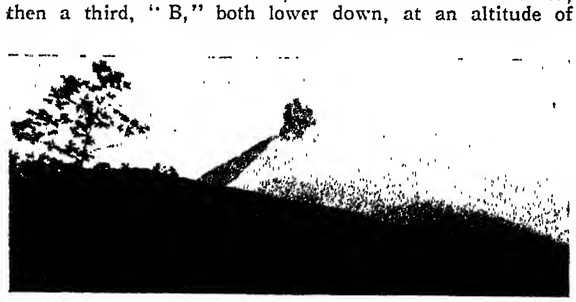

FIG. 2.—Vesuvius as seen rom the Observatory Ridge, May 29, 1905. From a photograph by Prof. G. Mercalli.

about 1180 metres, and both westward of the first, and nearer the station of the funicular railway.

For some weeks lava issued from these outlets and flowed down the mountain-side in two parallel streams, which from Naples had the appearance of two lines of fire running down the slope of the great cone; towards June 25 the current from "A" ceased, but the stream from "B" continued, and flows more actively than before.

On reaching the base of the great cone (800 metres), the lava piled itself up in the space between the cone and the hill formed by the lava-flow of 1895; a stream branched off, first toward Mount Somma, but afterwards in a south-south-west direction, and a small stream more fluid than the main body ran to within a short distance of the electric railway which plies between the observatory and the lower funicular station. Near the fumarole "B" a small heap of scoriæ (a driblet-cone), about 4–5 metres in height, has sprung up; but apart from the explosions attendant on its formation, and which only lasted a few days, there has been no disturbance in the regular flow of the great streams.

The line of white steam seen in Fig. 2 shows the position of the outlets and the course of the lava streams as seen from the observatory ridge; the black smoke issuing from the crater indicates the cloud of non-incandescent dust which was cast up after the partial falling in of the walls of the smaller cone on the summit.

We may perhaps attribute the frequency in these latter years of the lava streams from lateral outlets to the increased height of Vesuvius (now about 1330 metres), for the column of fluid lava, when inside the cone, is forced up to a higher level and exerts greater hydrostatic pressure on the sides of it, which are, moreover, much seamed. Formerly, when the mountain was lower, as, for instance, between the years 1840 and 1850, the lava streams generally flowed from the top.

The Millport Marine Station.

SINCE the efficiency of such an institution as a biological station is so largely dependent upon the completeness of its library, I do not think any apology need be offered for appealing to those readers of NATURE who are interested in marine biology for assistance in an endeavour to bring together for the use of those working at the Millport Marine Station as complete a collection as may be possible of works having any bearing on the fauna and flora of the European seas. The station already possesses a considerable proportion of the more important monographs, as well as a number of useful pamphlets; but there are still lacking many reference works of importance, and I am sure that copies of some of these will exist among the duplicates in many a naturalist's library. I would also urge the claims of the Millport Station upon the generosity of authors for separate copies of any papers they may publish; and in this connection it should be noted that the council of the association has recently agreed that all material intended for private research shall be supplied absolutely free of charge.

This occasion may also be utilised to point out some of the advantages which the Millport Marine Station offers to the research student. The fauna of the Clyde area is an extremely rich one, and the water in the vicinity of the station is of most remarkable purity, so that even quite delicate species can be readily kept alive in the tanks. A small steamer, the *Mermaid*, specially built for scientific research, is constantly at work during the summer months, and brings in daily an abundant supply of material. The tank-room, only part of which is open to the public, has recently been greatly extended, and now has facilities which are probably unsurpassed anywhere for the accommodation of invertebrates and the smaller vertebrates; the tanks are mostly of glazed fire-clay, and capitally adapted for observation and experiment. Besides a well-equipped private research room, there are seven screened compartments in the general laboratory affording ample accommodation for nine students, while a large class-room recently added has benches for forty-five students.

The station is lavishly equipped with apparatus of all kinds—for instance, the student will find here every facility for advanced physiological work. In fine, I think it may fairly be claimed that nowhere in the British Isles will the student find facilities for research on marine biology such as exist at Millport; and, indeed, I know of no marine station elsewhere which can, all things considered, offer greater advantages to the biologist. Lastly, it may be mentioned that although the fees are very low, there is never any difficulty in arranging for a free table.

S. PACE (Director).

Millport Marine Station, N.B.

THE TOTAL SOLAR ECLIPSE, AUGUST 30.

(1) THE SOLAR PHYSICS OBSERVATORY EXPEDITION.

Palma, August 26.

IN another four days the eclipse will be an event of the past, and we shall be packing up the great amount of material which we have been setting

FIG. 1.—Our camping ground as seen from the south-east end. n the long tent on the left is the 76 ft. prismatic reflector, and all the other instruments are beyond it. Notice the poles for the discs in the right-hand corner.

up with so much care since August 11. The greatest keenness has been displayed in every party told off for its particular duty, and I think that everyone will be glad when the eventful day arrives.

We have settled down to routine work every day. Those in charge of instruments go to the camp at about 6.15, and work at the adjustments and small items so necessary for successful photographs. At nine o'clock the whole band of volunteers, now about 150 in number, arrives at the camp, and three drills are then gone through in fairly quick succession. The organisation of the division of labour at each instrument is now very satisfactory, and the various movements that have to be performed at stated times occur in clockwork fashion.

FIG. 2.—The camp as seen from the south-west end of the ground. The 3½-inch McClean equatorial in the foreground, 16 ft. coronagraph under tent on left, 76 ft. prismatic reflector under canvas on the right. All these instruments are housed with sails and spars from H.M.S. *Venus*.

As I have mentioned before, the whole work of the camp is organised according to signals given by the

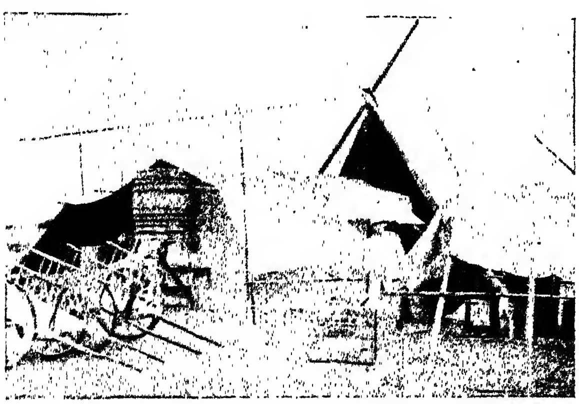

FIG. 3.—The north end of the 76 ft. prismatic reflector, showing the dark room with the wine-tub for water, the two handcarts loaned us, and on the right, under the small awning, the 3-prism 6-inch prismatic camera.

eclipse clock. There are, however, two further signals given from the angles subtended by the cusp at the centre of the dark room. These angles, which have been previously calculated, give us 16 seconds and 5 seconds respectively before the commencement of totality. The object of employing these times is not so much to assist the observers in the camp generally, as to warn the workers with the prismatic cameras, who begin making their exposures three seconds before the commencement of totality. Both Mr. Butler and myself utilise these two signals to begin our series of snap-shots for photographing the lower chromosphere.

Undoubtedly the three minutes three seconds, the length of totality at this station, is a long time, and when the strong voices of the timekeepers are heard shouting out "163 seconds," "153 seconds more," &c., one somehow feels that one is not utilising to the fullest extent the time available.

With the prismatic camera, of which I am in charge, it is hoped to secure fourteen photographs. The three large 6-inch prisms of 60°, and the object-glass of the same diameter, form together a powerful weapon of research. The programme of work is to make four snap-shots at about the commencement of totality and five about the end. The remaining five plates will be exposed for intervals varying from 5 to 90 seconds, and it is hoped that the two long exposures on each side of mid-totality will add to our knowledge of the wave-lengths of the coronal rings. This prismatic camera is designed to give results suitable for determining accurate wave-length of the chromospheric and corona arcs; the image of the sun is therefore small, and the dispersion large.

The prismatic reflector of 76 feet focal length, in charge of Mr. Butler, provides a solar image of about 8 inches diameter, and, since the light is made to pass through one prism twice, the dispersion is not excessive. The large chromospheric arcs should, however, provide us with much matter for thought.

This latter instrument is practically ready for the eclipse, and a few words may here be said as regards the erection of it. The camera end itself forms part of the dark room of the camp, and is to the south of it. Just outside, but a little to the west of the north and south line, is the siderostat, which throws the solar rays on to the long-focus mirror situated to the south about 70 feet. This concave reflector throws the image towards the north, into the portion of the dark room in which is fitted a screen. An arrangement is adopted for inserting, during some periods of totality, a prism in front of the mirror. The light from the siderostat has thus to pass twice through the prism, giving a very useful

spectrum. The large size of the image involves the use of very great photographic plates, and in this case plates 2 feet square and 2 feet by 1 foot will be used.

In order to keep out the light from the cloth tube connecting the mirror with the camera, sails have been erected on large spars, making the whole tube a very imposing structure.

Two new additions to eclipse drill have been introduced to render the organisation more perfect and flexible in exceptional circumstances, and both of these have been proved to be necessary. During one

FIG. 4.—The timekeepers at work with the eclipse clock, and their audience.

of the rehearsals the other day the eclipse clock stopped owing to the hand coming in contact with the dial over which it moves. Such an occurrence has never been known in our eclipse history before, and the timekeepers remained dumb after counting "163 seconds more." In future, a man with a stop-watch will stand with the timekeepers and keep a tally of the 10 seconds as they pass.

The second innovation was prompted by the possible absence on the day of the eclipse of any one member of a group working an instrument. Unfortunately, I

FIG. 5.—The cœlostat end of the 16 ft. coronagraph, which is under the tent on the right.

had to spend the whole of Saturday, August 26, in bed by the doctor's orders; but my instrument was very efficiently worked by the navigating officer, Lieut. Horne, who will make the cusp observations from my siderostat during the eclipse. In each party, then, the work of each member was changed, and drills were carried out under this scheme with success. I should like to take this opportunity of thanking most heartily both Staff-Surgeon Clift and Surgeon Jones, of H.M.S. *Venus,* for their very kind and efficient assistance on that occasion.

The camp at the present time practically fills the whole of the enclosed ground placed very generously at our service. Through the kindness of the local authorities, extra tents have been provided, and much material loaned in the way of wood for the shadow-band party, handcarts for the use of the men bringing water and provisions from the ship, &c.

To avoid the inconvenience of any dust arising from the road to the north of the camp, the same authorities will keep this well watered on the day of the eclipse, and for some days previous to it, and they have also arranged that the manufacturers' chimneys, which are very numerous here, shall not smoke during the time of the eclipse.

WILLIAM J. S. LOCKYER.

(2) REPORTS OF OBSERVATIONS.

Up to the time of writing very few details as to the actual scientific results obtained during the total eclipse of the sun on August 30 have arrived in this country; but it is very clear that the hopes expressed in these pages on August 24 have not been completely realised on account of the prevalence of cloud during totality at several stations.

Telegraphing from Castellon, Prof. Callendar states that, although the first and last contacts were observed in a clear sky, totality was entirely obscured by clouds. Good records of radiation and temperature were, however, secured. Similarly, Mr. Evershed, who had set up a very fine prismatic camera near to Burgos, says in a telegram to the Royal Society, "Thick clouds; no results." This forms a striking contrast to the reports of the Press correspondents, which state that all the observations at Burgos itself were successfully carried out during a temporary break in the clouds. A reproduction of a photograph of the corona, taken with a camera of 48 inches focal length by Mr. J. T. Pigg at Burgos, appeared in the *Daily News* for September 2.

At Palma, Majorca, the expedition from the Solar Physics Observatory, South Kensington, under the direction of Sir Norman Lockyer, and assisted by the officers and crew of H.M.S. *Venus,* were apparently only a little more successful, for as the crucial moment of totality arrived dense clouds came up and obliterated the sun. At about mid-totality, however, a break in the clouds occurred, and some photographs were secured which, it is hoped, may at least show the form and extent of the corona. Several good drawings of this feature, which was of the "maximum" type seen in 1871 and 1882, were made by the "disc" sketching parties.

At Saragossa, cirrus clouds prevented observations being made.

Encouraging but brief reports have been received from the observers at the North African stations.

Mr. Newall, at Guelma, appears to have been singularly fortunate, for he reports "superb weather conditions, observations successfully made," and states that he observed a brilliant corona of the "maximum" type having remarkably long streamers —one of which extended towards Mercury for more than three degrees—and unusually dark rays. Splendid prominences were also observed by him.

Sir William Christie's report from Sfax is not quite so sanguine, for he states that the sky was partially cloudy; nevertheless, photographs were secured with all instruments, and the eclipse was satisfactorily observed. A Reuter telegram from this station says that during the period of totality no clouds interfered with the observations.

At Assuan, where Prof. Turner set up his coronagraph and polariscopic apparatus, the atmospheric conditions were perfect, except for a slight haze, and the *Times* correspondent reports that eight photographs in polarised light were obtained and successful corona pictures were taken. Mr. Reynolds with his 120-feet reflector evidently experienced the great drawback common to all users of long-focus cameras, viz. bad atmospheric tremors, for the local fire brigade had to be requisitioned to flood the site in order to check the radiation from the heated ground.

Dr. J. Larmor sends us the following observations made by Mr. S. L. Walkden on the Orient steamer *Ortona*, situated on the central line of the eclipse in the Mediterranean near the Spanish coast. The observations contain a good naked-eye record of the eclipse, and agree with Dr. Larmor's impressions:—

"Rainbow colours visible on small cloud about 5° from sun about ½ minute to 1 minute before totality. Pulsation of light from strip of sun was observed by Mr. Campbell and myself as if the moon advanced by stages. (Probably another aspect of shadow-bands phenomenon.) No approach of shadow observed by myself, though keenly looked for; but found no one else who observed it except Mr. Campbell, who caught it in the sky not far from sun's limb at time of approach of totality. *Totality*.—Venus first noticed about one minute before totality, and Regulus as soon as totality complete. Mercury searched for with Zeiss field-glass and naked eye, but *not* caught after about 10 to 15 seconds' search. *Corona*.—Very fine and very detailed, so that general description difficult. *General impressions*.—(1) Some streamers seemed to cross, and were certainly not all radial. (2) Obvious extension seemed about two sun diameters. (3) Streamers distributed all round sun, but chiefly at left-top (45° from top) limb. Long thin streamer at left-left-bottom limb (67½° to left of bottom). *Prominences*.—Distributed more or less all round, but chief one observed at left-top corner. Height about ¼ of sun's radius; but this should be corrected for irradiation, which made the prominence appear to trespass into the moon's surface, exaggerating its size and producing general local glare. Colour of prominence was much less marked than expected, being merely of a violet or faintly rosy-pink hue. Shadow bands observed on deck at end of totality (looking down from boat deck). They 'rippled' along a little faster than could be easily followed by eye. They were parallel to the strip of the sun after totality, and travelled in direction of shadow. Dark strips about 6 to 8 inches wide, distance apart about 18 inches. During totality depth of darkness seemed practically independent of depth of our immersion in shadow. Clouds formed a good deal after ⅘ of sun's diameter had gone. *Lightness* of eclipse very marked, and in itself disappointing. Time by watch always plainly visible. Sky illumination greatest round horizon, and a yellow glow (like sunset) in points *opposite* to sun (about N. point). Coast lights were visible a few miles away, and one hill to N. appeared as if *perforated*, with the sky showing through. This was observed by one other passenger. Venus still visible nearly 5 minutes after end of totality. Whole black disc of moon was visible shortly before totality, say 5 to 10 seconds before."

According to a correspondent writing to the *Times*, some interesting observations of a simple character were made by the amateur astronomers on board the P. and O. mail steamer *Arcadia*, which for the time of the eclipse waited off the coast of Spain not far from Castellon. Members of the British Astronomical Association were on board, and organised themselves to watch various features of the phenomena. Mr. and Mrs. Johnson report that they saw the whole contour of the moon projected on the corona immediately after the first contact. Thermometric observations showed a fall from 90° to 72°.6 in the sun, and from 82°.4 to 72°.5 in the shade, temperature. Mr. Bacon, first officer of the *Arcadia*, made successful observations of the approach and of the recession of the moon's shadow from a point of vantage at the mast-head.

As regards the observations made by foreign astronomers, those located at Castellon, Burgos, Guelma, Sfax, and Assuan shared, of course, in the conditions enumerated above. M. Trépied, of the Algiers Observatory, was apparently very successful at Guelma, and obtained numerous photographs of the chromospheric spectrum and the corona. A fall of temperature of 5° C. (from 33° to 28°) was recorded, and Mercury, Venus, and Regulus were observed.

At Tripoli, Prof. Todd, of Amherst College Observatory, M. Liberd, of Paris, and Prof. Millosevich, of Rome, were favoured with a clear sky. Prof. Todd secured some 250 photographs of the corona with his automatic coronagraph. Very good observations of the shadow-bands are said to have been made at this station.

A disappointing feature of the eclipse was the failure to secure observations at both ends of the shadow's path. As mentioned before in these columns, arrangements had been made by the Lick Observatory to photograph the corona in Labrador and in Egypt with exactly similar coronagraphs. Mrs. Maunder, accompanying the Canadian party at Hamilton Inlet (Labrador), was also to use a coronagraph identical in scale with that used by Prof. Turner at Assuan. A Reuter telegram from St. John's, Newfoundland, announces, however, that the Lick observers experienced a total failure owing to clouds; a second message from a telegraph station on Hamilton Inlet stated that fine weather prevailed from 7 a.m. to 6 p.m. on the day of the eclipse, and that the phenomena were perfectly visible, and it was hoped that the Canadian party had been successful in making good observations. A later telegram, dated September 3, states, however, that the expedition was entirely unsuccessful, owing to the cloudy weather, and no photographs were secured.

A communication from Mr. J. Y. Buchanan, F.R.S., to the *Times* of September 5, contains some interesting notes of visual observations made during the period of totality at Torreblanca, a small village on the east coast of Spain. Having been present at the 1882 eclipse, when he assisted Sir Norman Lockyer at Sohag, on the Nile, and not having *seen* the whole of the phenomena, Mr. Buchanan only took with him an ordinary camera and a field-glass, so that he might devote all his attention to visual observations. His choice of Torreblanca, where, with the exception of the local railway employees, he seems to have been the sole observer, was justified, inasmuch as the eclipse took place in a blue sky. As the last vestige of sun disappeared behind the eastern limb of the moon a magnificent bunch of prominences, of a light violet hue, appeared at the same part of the limb; but these subsequently disappeared, and a careful search at mid-totality failed to reveal any prominences at all. A similar group, however, burst into view on the opposite limb just before the end of totality, thus indicating that the apparent diameter of the moon was sufficient to cover the whole of the prominence layer of the sun's limb at mid-totality.

The corona was clearly visible near to the western part of the moon's limb eight seconds before the advent of totality, and throughout totality it was very clearly defined. On an average it extended to rather more than one lunar diameter from the limb, but a streamer on the lower western limb was judged

to extend to at least twice this distance. The whole corona had an appearance of movement, suggesting to Mr. Buchanan certain features which occur when a search-light illuminates the atmosphere.

Observations of the partial eclipse are of no great interest as compared with those made during totality, but a number of thermometric readings were recorded at numerous stations. Mr. Spencer Russell, in a communication to the *Standard* for September 2, gives a table of fifteen-minute observations of a wet and dry bulb thermometer, made at Epsom between 11.45 a.m. and 2 p.m. on the day of the eclipse. Whilst the wet bulb readings remained constant at 53° F., the dry bulb showed a minimum temperature of 54° F. between 12.45 and 1.30 p.m. Photographs of the partial eclipse were secured by Messrs. Spencer and Butler during a balloon journey from Wandsworth to Caen in Normandy.

An interesting record of a series of "pin-hole" images of the crescent sun reaches us from Sir Joseph Fayrer, F.R.S. Whilst sailing in a ten-ton boat having a large mainsail, he observed the partial eclipse under favourable conditions in Falmouth Bay. About 1 p.m. a slight breeze caused the sail to incline from the perpendicular, and a number of well defined crescent images were projected on to the whitened deck of the boat, and occasionally on to the water. An investigation showed that these images were formed by a series of eyelet holes, used for the balance reef, high up in the sail. The phenomenon was so vivid and the images so sharply defined as to appear worthy of record.

A correspondent to the *Daily Graphic* (September 2), the Rev. Frederick Ehlvers, rector of Shaftesbury, Dorset, records the remarkable phenomenon of an evening primrose unfolding itself during the eclipse as if evening had arrived. Observers at the Solar Physics Observatory, South Kensington, were prevented by clouds from seeing the eclipse, except for one or two breaks of short duration. About one minute before last contact, however, the sky suddenly became clear for a short distance around the sun, and brilliant sunshine prevailed as the last trace of the moon left the solar disc.

TECHNICAL EDUCATION IN NATAL.[1]

THE report of the commission appointed to inquire into technical education in Natal has just been received. It is signed by eleven out of twelve of the commissioners, and Mr. C. I. Mudie, superintendent of education, has forwarded a minority report.

The commission, under the presidency of Sir David Hunter, K.C.M.G., held eleven meetings and examined fifty witnesses; some of the members were also sent to Johannesburg to confer with the council and board of studies of the Transvaal Technical Institute. Delegates from the Orange River Colony also attended the conference.

The commission finds that Natal, with its European population of 97,109, has as yet but meagre provision for technical and higher education, and, indeed, states that boys who had received primary and secondary education in the colony were frequently found to be so deficient in general knowledge that they were not well qualified to enter upon technical education.

The result of inquiries as to the probability of youths availing themselves of instruction should it be placed within their grasp was decidedly encouraging, and the commission concludes, from the evidence and statistics, and from the fact that considerable sums are being expended by individuals in Natal on American correspondence classes and private tuition, that there is an urgent necessity for more adequate provision to equip the youth of the colony for the battle of life.

The resolutions of the conference held at Johannesburg point out that there is a present and immediate need for a full teaching university in South Africa, and that the colonies in which the university may not be situated should each have one or more colleges or institutes devoted to higher or technical education which should be recognised by the university council as integral parts of that teaching university, and that the university should grant diplomas in professional subjects, and degrees in arts and science, in the faculties of (1) education; (2) engineering, including mining; (3) agriculture; (4) law; and (5) medicine.

The recommendations of the commission are based upon the resolutions of the conference, and suggest that immediate steps should be taken by the Government to provide for higher education; that a council be appointed by Government to organise and control technical education in Natal which shall be independent of the education department, although that department should be represented on the council. It suggests that specialists be obtained as lecturers in (1) chemistry and metallurgy; (2) physics and electrotechnics; (3) natural science (botany, zoology, geology, physiology); (4) pure and applied mechanics; (5) modern history and literature; while other subjects would be taught by local part-time men.

It is suggested that Pietermaritzburg has first claim for this college, but that Durban also has claims, and the commission thinks that the foregoing lecturers should be peripatetic, in the first place teaching at Pietermaritzburg and Durban only, but as occasion required going farther afield.

While appearing to have somewhat wide views as to the subjects that should be taught—for twenty-six branches are mentioned in the list of subjects in which the commission finds there is a need for classes—the estimates of cost are strictly moderate, for the annual expenditure is taken at 6500*l.*, and the initial expenditure to provide the necessary equipment for engineering, chemical, physical, natural science, and other laboratories is estimated at about 2000*l.* It is true that no provision is made in this estimate for rent or capital expenditure on buildings, but we should think even without these the estimate was likely to be exceeded.

All institutions, however, must have a beginning, and those which start with the highest aspirations have a good chance of attaining some, if not all, of their objects. There can be no doubt that technical education should be conducted everywhere quite apart from the education department, and as much as possible under the guidance of men who are acquainted with some at least of the subjects that are being taught. Technical education, especially in the colonies, should be made accessible to everyone, and should more especially offer inducements to those who are working for their living to improve their knowledge of the sciences which underlie their handicrafts. If this be the first object in view, it will be evident that evening classes and evening laboratory work must be undertaken before any attempt is made to form day classes. It appears to be chiefly on this subject that Mr. Mudie dissented from the report of the commission, for he thinks the college at Pietersburg, which, as he says, covers a preparatory, a high school, and a college proper, should form the nucleus of a university college in Natal. It would not seem to be a desirable thing to commence operations in this way for many reasons, the principal of

[1] Colony of Natal. Report of the Technical Education Commission May, 1905. (Maritzburg: P. Davis and Sons, 1905.)

which is that artisans, clerks and others, for whom technical education is primarily provided, while wishing to learn, have in many cases left school so recently that they do not wish to return, and those of maturer age are not always quite certain whether their dignity will allow them to go to school again.

THE WOBURN EXPERIMENTAL FRUIT FARM.

The fifth report on the Woburn Fruit Farm, by the Duke of Bedford and Mr. Spencer U. Pickering, F.R.S., contains a very useful summary of the results of ten years' experiments and observations on apple-trees. The conclusions arrived at are based on measurements of leaves, trees, and fruits, and also on weighings of the fruit. The average size of the leaf of the tree seems gradually to diminish with age, and there is a similar but less marked tendency in the fruit. The experiments indicate no advantage from heavy thinning of the fruit, for the size was not increased; hard pruning proved unprofitable, unpruned trees were three times more productive than those heavily pruned; summer pruning was found not to be desirable, and even moderate root pruning was found to injure the trees. Apple-trees transplanted at 2–3 years old were found to grow better than either younger or older plants.

A very curious result which for some time puzzled the experimenters was that carelessly planted trees, though weak at first, ultimately made more growth than those carefully planted. A satisfactory explanation has, however, been found. The roots of carelessly planted trees are so much injured that they make scarcely any growth; the result of this is that numerous new roots grow from dormant buds higher up the stem, and these new roots, not having suffered from transplantation, ultimately surpass in size the original roots of carefully planted trees.

The results obtained at the Woburn Fruit Farm are to some extent due to the particular soil—a moderately stiff clay—but it is probable that the conclusions arrived at would be found to hold good in many English orchards. It is, however, a very difficult thing to judge how far conclusions of the foregoing kind, based on a particular set of conditions, apply under different conditions, and the practical value of the long series of experiments and observations made at Woburn would be very greatly increased if similar experiments were conducted on a soil, or soils, of different character. In any action which the Board of Agriculture and Fisheries may take upon the report of the "Fruit" Committee, it is to be hoped that the important work of the Duke of Bedford and Mr. Pickering may be followed up and extended.

T. H. Middleton.

NOTES.

To commemorate the meeting of the British Association in South Africa, a scheme has been formulated to found a British Association medal for South African students. This announcement was made by Prof. Darwin at the close of his presidential address at Johannesburg. A visit was paid to the Johannesburg Observatory on August 30, and the opportunity was taken of pointing out to Lord Selborne the suitability of the site for a fully-equipped observatory and the necessity for more astronomical work in the southern hemisphere. Referring to this suggestion in the course of his speech introducing Prof. Darwin as president of the association, Lord Selborne is reported by the *Times* correspondent to have said that "he greatly regretted he had been obliged to refuse the only request that the association had made to him—namely, to find funds for the establishment of a proper observatory in Johannesburg. He was obliged to say that all the revenue they at present possessed was required for the development of their material resources and means of communication; but where the Government was powerless, what a magnificent opportunity there was for a patriotic Transvaal. For a site in the purest atmosphere, 2000 feet above the highest observatory now existing, only 10,000*l*. was required. There they might establish a telescope which would help observers in the southern hemisphere to compete with the astronomers of the northern hemisphere. The site was there, and it was already occupied by a perfectly equipped meteorological observatory." All the papers on South African matters read during the meeting are to be published in a separate volume by the South African Association for the Advancement of Science. At the closing meeting, held on September 1, Prof. Ray Lankester was elected president of the association for 1906.

Mr. J. W. Douglas, one of the editors of the *Entomologist's Monthly Magazine*, died at Harlesden on August 28 in his ninety-first year.

Three distinct earthquake shocks, the severest ever experienced in the district, were felt at Portsmouth, New Hampshire, on August 30, beginning at 5.40 p.m.

Reuter's correspondent at Stockholm reports that Prof. Nathorst has received a letter in which Lieut. Bergendahl, who is a member of the Duc d'Orléans's Greenland Expedition, states that on July 27, as the expedition passed Cape Bismarck, unknown land was discovered. It appears that Cape Bismarck lies on a large island, and not on the mainland. The new land has been mapped as well as possible, and has received the name Terre de France. The expedition was unable to penetrate further north than 78° 16′ N. lat.

At the annual meeting of the Academy of the Lincei, which was held on June 4 in the presence of the King and Queen of Italy, the president, Prof. Blaserna, announced the result of the competition for the three Royal prizes founded by the late King Humbert. In the section of normal and pathological physiology, the prize is awarded to Prof. Aristide Stefani, of Padua, for his published work dealing with the physiology of the heart and circulation, the non-acoustic functions of the labyrinth of the ear, and the serotherapeutic treatment of pneumonia. In the sections of archæology and of economic and social science, the judges reported that the competitors were not of sufficient merit to justify the award of the prizes. This is the first occasion on which so small a proportion of the prizes have been conferred, and it is proposed that in future the section of archæology shall embrace not only classical, but also Christian and mediæval archæology. Ministerial premiums intended to aid original work among teachers in secondary schools were awarded in the department of mathematical sciences to Prof. Ciani (50*l*.), Prof. Pirondini (38*l*.), and Prof. Chini (20*l*.). Out of the funds available from the Carpi prize, a sum of 32*l*. was awarded to Dr. P. Enriques for a thesis on the changes brought about in absorbed chlorophyll by the action of the liver, and the relation existing between the derivatives of chlorophyll produced in the organism and the genesis of the hæmatic pigments. In his address the vice-president, F. d'Ovidio, discussed in general terms the question "Art for Art's Sake," dealing more particularly with the influence exerted on national life and character by art and literature.

THE *Popular Science Monthly* (vol. lvii., No. 4) contains a suggestive article by Prof. John M. Coulter on the methods available for arousing public interest in scientific research. The results of scientific work usually reach the public through the medium of reporters to the newspapers and writers for the magazines; the material dealing with original research is, generally speaking, scant in amount, sensational in form, and wide of the mark. It is urged that men of science should, so far as possible, be their own interpreters, so that the misleading statements of the "middle man" may be avoided. Particularly, not only the facts of the investigation, but its general bearing should be made clear; it is this feature that the reporter always misses, and a "strategic movement is represented to the public as a dress parade." As a justification, it is contended that research will be shown to be practical, and a more ample endowment be secured for it. "The question of adequate support for research is the most serious one that confronts American science to-day." The appeal to American interest is utility, and it is necessary to show that practical results are reached most surely and most quickly from the vantage ground of pure science.

THE report of the commission appointed for the investigation of Mediterranean, or Malta, fever (part iii.), recently issued by the Royal Society, contains the important announcement that goats seem to be capable of transmitting the disease. The evidence supporting this conclusion is as follows:—On June 14 Dr. Zammit examined six goats, and found that the blood of five of them gave the agglutination reaction for Mediterranean fever. This was confirmed by Major Horrocks, R.A.M.C. Major Horrocks and Dr. Zammit then undertook the examination of eight different herds of goats, and in every herd examined an average of half the animals (from 7·6–75 per cent.) gave the agglutination reaction for Mediterranean fever. It was also found that one or more apparently healthy goats in every herd were excreting the specific organism of the disease—the *M. melitensis*—in their milk and urine, the number of the organism in the milk being very large. It would seem probable, therefore, that infected goat's milk may be the source of infection of man, particularly as monkeys may be artificially infected by feeding with material containing the specific organism, as has been detailed in a previous report. It is of interest that in Gibraltar, where the disease is also very prevalent, goats are almost the only source of the milk-supply.

THE report of the Government analyst of Trinidad for the year 1904–5 contains several points of general interest. Samples of water from the Carrera Convict Depôt have been examined to ascertain if a connection could be traced between the water supply and the prevalence of diarrhœa and dysentery among the prisoners. Very small proportions of lead, copper, and zinc were found to be present, and, in view of the fact that all attempts made during several years past to trace the epidemic to other causes have been unsuccessful, it appears possible that the metallic impurities named are responsible for the trouble. Before the question can be definitely decided, further investigation will be necessary. The aërated waters which are largely consumed in the colony were found to be usually contaminated with lead, owing to the use of an impure sulphuric acid in their manufacture, to an extent likely to prove dangerous. It is suggested that the use of liquefied carbon dioxide, such as is now imported into the colony in cylinders, would be a remedy for the difficulty. The adulteration of milk has very much decreased owing to the system adopted of suspending the licenses of sellers convicted of adulteration during the past year. Previously the Board of Health did not refuse the renewal of licenses, either temporarily or permanently, but only issued warnings.

THE fishes of Puget Sound form the subject of a paper by Messrs. Gilbert and Thompson in the *Proceedings of the U.S. Nat. Museum* (No. 1414). The paper is based on a collection made in 1903, which included two species regarded as new and six not previously recorded from the area in question.

THE opening article in the first part of the third volume of the quarterly issue of *Smithsonian Miscellaneous Contributions* is a translation of Dr. E. Mascha's valuable paper on the minute structure of the flight-feathers of birds, originally published in the *Zeitschrift für wissenschaftliche Zoologie*, and already noticed in our columns. Among the original communications, special reference may be made to one by Mr. F. W. True on the skull of an extinct sea-lion (Pontoleon) from the Miocene of Oregon, apparently the earliest known representative of this group of seals; to a second, by Mr. A. Mann, describing the extreme beauty of the surface sculpture in diatoms ("Diatoms, the Jewels of the Plant-World," it is called); and to a third, by Mr. C. A. White, on the ancestry of the North American pond-mussels of the family Unionidæ, in which it is concluded that all the living forms in this particular area are descended from fossil local types. It may be added that if we accept the views on nomenclature expressed in yet another article, the well known name Dromæus (for the emeu) has to give place to Dromiceius.

THE *Proceedings of the American Philosophical Society*, Philadelphia (xlix., No. 179), contains papers on the Filipino, on the Aborigines of Western Australia, on the osteology of sinopa, and on the marsupial fauna of the Santa Cruz beds. In an article on the oligodynamical action of copper foil on certain intestinal organisms, Mr. Kraemer concludes that intestinal bacteria such as the colon and typhoid bacilli are completely destroyed by placing clean copper foil in water containing them, and that certain of the lower animal and vegetable organisms possess a special sensitiveness to minute quantities of copper. The copper is probably in the form of a crystalloid rather than that of a colloid. It will be remembered that Dr. Moore, of the United States Department of Agriculture, has suggested the use of copper salts and of bright copper for the purification of water supplies. In another article Dr. Wiley discusses the effects of preservatives in food on metabolism, and expresses the opinion that boric acid and borates in any quantity upset digestion, and even in small doses, if given over a long period, have an unfavourable effect on health and digestion.

A PAPER by Dr. W. T. Calman, of the British Museum, on the Crustacea of the group Cumacea from the west coast of Ireland, published as No. 1, part iv., of Scientific Investigations, 1904, by the Irish Department of Agriculture and Technical Instruction, illustrates the importance of collecting on a thoroughly practical and effective system. During the entire cruise of H.M.S. *Challenger*, for instance, the whole collection of Cumacea was represented by no more than fifteen species, whereas Mr. E. Holt, the collector of the specimens submitted to Dr. Calman, obtained within a small area representatives of no less than forty-eight species, of which nine are regarded as new, one being so aberrant as to be assigned by its

describer to a separate family group. Most of the specimens were collected by means of tow-nets attached to the back of a trawl in such a position as to capture any creatures disturbed by the ground-rope.

In the report on the sea and inland fisheries of Ireland for 1902 and 1903, part iii., scientific investigations, Mr. E. W. L. Holt, the scientific adviser of the fisheries branch of the Board of Agriculture and Technical Instruction for Ireland, takes a broad view of the services which scientific investigations can render to practical fishery problems. Not only are such subjects as oyster culture, the artificial propagation of the Salmonidæ, and the mackerel fisheries dealt with, but the various appendices to the report constitute a most valuable addition to our knowledge of the invertebrate marine fauna of Ireland, more especially of the very interesting and little-known fauna occurring in the deeper water off the west coast. The most important paper, from a scientific point of view, is that contributed by Mr. Holt himself, in collaboration with Mr. W. M. Tattersall, on the schizopodous crustacea of the north-east Atlantic slope, in which a great number of new or little known species are fully described and figured. Other papers deserving special notice are Mr. G. P. Farran's account of the copepoda of the Atlantic slope, and the interesting contributions of the Misses Delap on the rearing of *Cyanea lamarcki* and on the plankton of Valencia Harbour from 1899 to 1901. The whole report, which treats of both sea- and fresh-water fisheries, is well illustrated with a large number of plates and diagrams excellently reproduced, and reflects great credit upon the department responsible for the scientific study of the Irish fisheries.

The *Pioneer Mail* of July 28 published an account of the phenomenal storm of wind and rain which devastated a large portion of the province of Gujarat between July 22 and 24, owing to which it was estimated that about 10,000 people were rendered homeless. The storm seems to have been most severe at Ahmedabad, 310 miles north of Bombay. The average annual rainfall of that place is only about 33 inches; during the storm in question it was stated that fully 37 inches were measured in two days. We find from the Official *Indian Daily Weather Report* that the fall was over-stated, but that nevertheless it was quite abnormal; 14 inches fell in twenty-four hours ending 8h. a.m. July 23, and 12½ inches on the following day. The Government meteorological reporter states that the fall was due to a severe cyclonic storm passing over the head of the peninsula, and to the fact that when it entered Gujarat it was fed by strong winds from the Arabian Sea.

We have received "British Rainfall, 1904," being the forty-fourth annual volume of this very useful publication, containing the carefully prepared results of observations taken at nearly 4000 stations. Dr. Mill states that every return undergoes critical examination before the results are published, a task that must strain the energies of himself and his small available staff to the utmost. While every page of this now somewhat voluminous work contains information of the highest value in connection with the distribution of rain over the British Isles, it is difficult to fix upon any particular portion calling for especial remark. One new feature is the publication of complete daily records for ten selected stations, and, as last year, attention has been given to a discussion of some of the wettest days, illustrated by special charts. There are also several interesting articles dealing with various branches of rainfall work, *e.g.* an analysis of the observations on the summit of Ben Nevis and at the base station at Fort William, for the years 1885–1903; for more complete details reference is made to an exhaustive discussion published by Mr. A. Watt in the *Journal of the Scottish Meteorological Society*. Another article deals with October rainfalls; this is generally the wettest month of the year over the greater part of England. In the present case, special reference is made to the comparatively dry Octobers of 1879, 1888, 1897, and 1904; with one exception, October, 1904, was the driest on record since the foundation of the British rainfall organisation. Another important article discusses the duration and average rate of rainfall in London since 1881. It shows *inter alia* that the rate of fall per hour is twice as great in July as in January.

We are glad to be able to reproduce from the *Annuario* of the Messina Observatory for the year 1904 an illustration of that important Sicilian station, which, under the able superintendence of Prof. Rizzo, undertakes, in addition to the usual meteorological observations, valuable

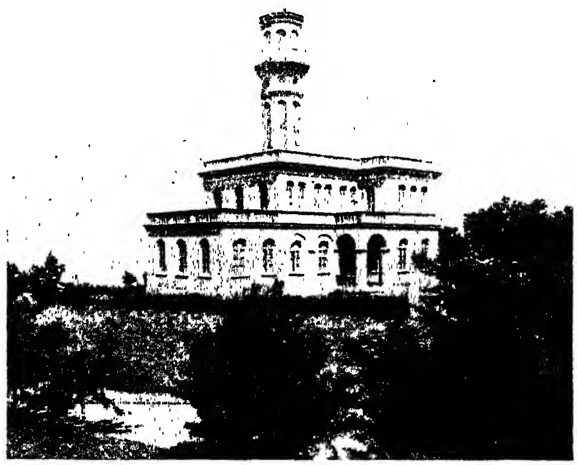

Fig. 1.—The Messina Observatory.

researches connected with solar and terrestrial physics. The institution has risen from modest beginnings in 1876, when, at the instigation of Prof. Manzi, it was attached to the Technical and Nautical Institute of that city. The importance of its work was soon recognised by the Central Meteorological Office at Rome, which supplied it with several instruments. The present edifice on the hill of Andria was completed in 1902, under the auspices of the Royal University of Studies at Messina, and occupies a position much better suited to its useful work; it is now removed from all disturbing influences, and we look forward with confidence to important results connected with the relation of magnetism to solar activity and to the movements of the ground, to which subjects Prof. Rizzo devotes special attention.

The International Council for the Exploration of the Sea continues to issue its publications in rapid succession. Of the Bulletins, which embody the records of the work more especially entrusted to it, we have received those for the terminal expeditions in November, 1904, and February, 1905 (Conseil Permanent International pour l'Exploration de la Mer, Bulletin, 1904–5, Nos. 2 and 3). We note, as additions to the routine observations of the council, an

extension of the surface observations made by merchant steamers on various routes, and a series of observations in February, 1905, made and communicated by the fishery branch of the Department of Agriculture and Technical Instruction for Ireland. It can serve no useful purpose to attempt the general discussion of the observations contained in these Bulletins as they appear; the general results can best be summarised at a later stage by the central authority, by whom the work will no doubt be undertaken. For the two dates concerned, a very marked feature of the observations in the English area is worth pointing out—the high salinity of the water at the entrance to the channel and to the west of Ireland. The origin of this salt water demands close investigation; it would seem to have come almost directly from the south, and in that event it is to be hoped that means of ascertaining whether Mediterranean water was present or not are available.

THE *Psychological Review* (article section) contains in its July number the following articles:—The synthetic factor in tactual space perception, T. H. Haines; consciousness and its object, F. Arnold; and a motor theory of rhythm and discrete succession (i.), R. H. Stetson. The first of these tabulates the results of certain preliminary experiments made by the writer in order to discover the exact relation between the two sorts of synthetic factor for local signs, viz. inner tactual sensations and the visual image. The main positions of the second article are these:—(1) Neither by introspection nor by any hypothesis of a consciousness aware of its own stream can we have any mental state in which consciousness does not have an object, and that object in the present; (2) the same holds for feeling and emotion; (3) the relation of thing to consciousness cannot be represented by any simple formulation like *aRx*, but is in reality much more complex.

THE July number of *Mind* contains an excellent article by Mr. R. F. Alfred Hoernlé on Pragmatism *v.* Absolutism, which is mainly occupied with a discussion of Mr. Bradley's views. The writer finds fault with Mr. Bradley's use of the criterion of non-contradiction, his neglect of epistemology in favour of metaphysics, his doctrine of "degrees of truth and reality," and his theory that "a self-consistent reality must *include* the appearances, and yet cannot be its appearances." Dr. Norman Smith, in a second article on the naturalism of Hume, deals sympathetically with Hume's treatment of ethics. He claims that "Hume may, indeed, be regarded, even more truly than Kant, as the father of all those subsequent philosophies that are based on an opposition between thought and feeling, truth and validity, actuality and worth." Other articles deal with Empiricism and the Absolute, Plato's view of the soul, and Symbolic Reasoning.

THE *Journal of the Anthropological Institute* (July–December, 1904) contains the Huxley lecture for 1904, presented by Dr. Deniker, the subject being "Les Six Races composant la Population actuelle de l'Europe." This is virtually a re-statement and a vindication of the racial division which was propounded by Dr. Deniker eight years ago in "Les Races européennes" (*Bull. Soc. d'Anthr.*, Paris, iv., 3), which the researches of later years have served to illustrate and confirm. To the Nordic, Ibero-Insular, and Western or Cevenole races (corresponding to the Northern, Mediterranean, and Central or Alpine races of other authors) are added three main races:—Eastern, brachycephalic, short and fair; Littoral or Atlanto-Mediterranean, mesocephalic, tall and dark; and Adriatic, brachycephalic, tall and dark. There are also four secondary races:—Sub-Nordic, brachycephalic, short and fair; Vistulan, brachycephalic, very short, fair or medium; North-Western, mesocephalic or brachycephalic, tall, medium or dark; and Sub-Adriatic, brachycephalic, and medium in stature and pigmentation. The maps of the average stature and pigmentation for Europe which accompany the paper are scarcely satisfactory. The cardinal principle laid down by Prof. Ripley, that the visual impression must, so far as possible, conform to the represented facts, has not been successfully followed, with the result that in the bewildering mass of detail no general impression can be gained by the eye without the assistance of the convention in the legend.

THE *Journal of the Franklin Institute* for August (clx., No. 2) contains papers of more or less interest, and covering most of the branches of science. Mr. Fuller discusses in a very complete manner the subject of sewage disposal and the pollution of shell-fish. A very full bibliography is appended to his paper.

WE have received from the Sytam Fittings Co., of Basinghall Buildings, Leeds, the catalogue of the company's system of filing, classifying, and indexing bottles, boxes, specimens, tubes, apparatus, &c. The company has applied the characteristics of the well known elastic or expansion series of bookcases to the purposes named, the specimen cabinets being built up of a number of interchangeable elements.

THE *Johns Hopkins Hospital Bulletin* for August (xvi., No. 173) contains an interesting account, by Dr. MacCallum, of the life and work of Marcello Malpighi, with full-plate portrait of this distinguished Italian anatomist of the seventeenth century. The concluding sentence of this article may be quoted:—"After all is considered the most enduring things in Malpighi's books are his perfect honesty, his extraordinary keenness and good sense in the interpretation of what he saw, and his ingenious objective methods of observation. What he saw could not have failed of being seen very soon by others, but we are filled with wonder that quite alone, with his 'quiet, eager mind,' he could have encompassed all, steadily searching out one thing after another throughout his forty years of restless activity."

WE have received the report of the second meeting of the South African Association for the Advancement of Science. It forms a handsome cloth-bound volume of 598 pages with 44 plates, and contains the forty-four papers read before the association printed in full. Summaries of the papers were published in NATURE (vol. lxx. p. 41) shortly after the meeting, and also the greater part of Mr. E. B. Sargant's address on the education of examiners (vol. lxx. p. 63). The presidential address by Sir Charles Metcalfe, and the sectional addresses by Mr. J. R. Williams on the metallurgy of the Rand, by Dr. G. S. Corstorphine on the history of stratigraphical investigation in South Africa, and by Sir Percy Girouard on improvements in rolling stock, are of permanent value, and the subjects and names of the authors of the papers make the volume an important addition to scientific literature, and show what a large amount of valuable scientific work is being done in South Africa. The illustrations are excellent. The coloured plates accompanying Dr. L. G. Irving's paper on miners' phthisis are admirably reproduced, as also are the photomicrographs of blue ground illustrating the paper by Mr. H. Kynaston and Mr. A. L. Hall on the geological features of the diamond

pipes of the Pretoria district. This paper is of special interest. In the Premier pipe a remarkable bar of purple quartzite, locally known as floating reef, occurs. It appears to be a mass of Waterberg sandstone that has dropped into the pipe. The blue ground is considered to be a serpentinised peridotite breccia with a specific gravity of 2·757. That of the Kimberley blue is 2·734.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NOVA.—A telegram from the Kiel Centralstelle, dated September 1, announces the discovery of a new star, by Mrs. Fleming at Harvard, on August 12. Its position, referred to the equinox of 1900, is given as follows:—

R.A. = 284° 2′ = 18h. 56·1m.
Dec. = −4° 34′,

and, although the magnitude is not mentioned, the Nova is said to be fading rapidly.

The position given above is near to that of λ Aquilæ, the Nova apparently forming the apex of an equilateral

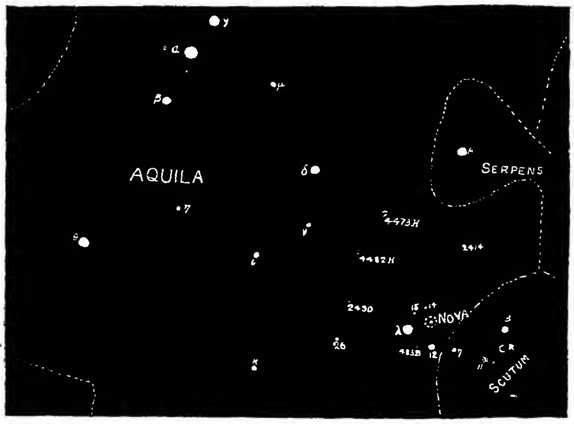

FIG. 1.—Chart of region about Nova discovered by Mrs. Fleming, August, 1905.

triangle which is completed by λ and 12 Aquilæ. The accompanying chart of the surrounding region shows the approximate position of the object.

A later telegram from Prof. Pickering gives the value R.A. = 18h. 57m. 8s. as being more correct for the right ascension of this object.

WATER VAPOUR IN THE MARTIAN ATMOSPHERE.—In Bulletin No. 17 of the Lowell Observatory, Mr. Lowell describes a new spectroscopic method for testing the presence of water vapour in the atmosphere of Mars, and Mr. Slipher discusses the results obtained from an experimental trial of the method. The principles involved are as follows:—Cosmically considered, the earth's atmosphere is at rest as regards a terrestrial observer, whilst the Arean atmosphere partakes of the planet's motion relative to the earth. This relative motion should be reflected in the solar spectrum, as obtained on a spectrogram of Mars, by a displacement of the lines due to the selective absorption common to both atmospheres. But in the terrestrial atmosphere water vapour accounts for a great deal of this absorption; therefore, if water vapour also exists in the Martian atmosphere the lines due to it should show a displacement, or at least a broadening, of such lines as those in the α band of the solar spectrum, or, with small dispersion, an extension on one side or the other of the band itself. The spectrum of the sunlight reflected by the moon, the approach or recession of which is negligible, is taken as the comparison spectrum, in which the earth's atmospheric absorption appears alone.

Mr. Slipher obtained several spectrograms of Mars and of the moon, the exposures being made when the respective bodies were at the same altitude. An examination of the α band and of the water vapour lines near D in both spectra seemed to indicate a slight shift, but the measurements made were uncertain and discordant, and no definite conclusion could be arrived at. So far as selective absorption is concerned, the spectrum of Mars seems to be the same as that of the equally high moon. Similar experiments on the planet Venus, using direct sunlight for the comparison spectrum, were equally inconclusive.

REAL PATHS OF LYRID METEORS.—The real paths of forty April meteors, recorded during the period 1889–1903 by different observers, are given by Mr. Denning in the *Observatory* (August). Many of the objects observed were Lyrids, and Mr. Denning emphasises the importance of this shower and its contemporaries, and, further, gives a daily ephemeris for the Lyrid radiant, based on his own observations of 703 meteors (186 Lyrids) during the years 1873–1904. This ephemeris covers the period April 15–April 25, but its author is doubtful of the radiant's activity on April 15, 16, and 25. On April 15 the computed position is $\alpha = 263\frac{1}{2}°$, $\delta = 33°$, and the latter value is constant. The right ascension, however, increases at the uniform rate of one and a quarter degrees per day.

OBSERVATIONS OF SATELLITES.—In No. 4035 of the *Astronomische Nachrichten* Dr. C. W. Wirtz publishes the results of a series of observations of various satellites made with the 49 cm. (about $19\frac{1}{2}$-inch) refractor of the Strassburg Observatory during 1902, 1903, 1904, and 1905. The results are given in a tabulated form, showing the differences between the calculated and observed position angles and distances. Dealing with Neptune's satellite, Dr. Wirtz found that it exhibits a marked variation of apparent brightness according to its position in its orbit. In longitude 40° (or position angle 60°) it is brightest, in longitude 240° (*i.e.* position angle 180°) it is least bright. Saturn's satellites, iii.–viii. inclusive, are also dealt with, the positions with regard to the planet and then to each other being given.

THE BRITISH ASSOCIATION.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY COLONEL SIR C. SCOTT MONCRIEFF, K.C.S.I., K.C.M.G., R.E., LL.D., PRESIDENT OF THE SECTION.

SCIENCE has been defined as the medium through which the knowledge of the few can be rendered available to the many; and among the first to avail himself of this knowledge is the engineer. He has created a young science, the offspring, as it were, of the older sciences, for without them engineering could have no existence.

The astronomer, gazing through long ages at the heavens and laying down the courses of the stars, has taught the engineer where to find his place on the earth's surface.

The geologist has taught him where he may find the stones and the minerals which he requires, where he may count on firm rock beneath the soil to build on, where he may be certain he will find none.

The chemist has taught him of the subtle gases and fluids which fill all space, and has shown him how they may be transformed and transfused for his purposes.

The botanist has taught him the properties of all trees and plants, "from the cedar tree that is in Lebanon even unto the hyssop that springeth out of the wall."

And all this knowledge would be as nothing to the engineer had he not reaped the fruits of that most severe of all pure and noble sciences—the science of numbers and dimensions, of lines and curves and spaces, of surfaces and solids—the science of mathematics.

Were I to attempt in the course of a single address to touch on all the many branches of engineering, I could do no more than repeat a number of platitudes, which you know at least as well as I do. I think, then, that it will be better to select one branch, a branch on which comparatively little has been written, which has, I understand, a special interest for South Africa, and which has occupied the best years of my life in India, Southern Europe, Central Asia, and Egypt—I mean the science of irrigation. My

subject is water—living, life-giving water. It can surely never be a dry subject; but we all know that with the best text to preach on the preacher may be as dry as dust.

Irrigation: What it Means.

Irrigation may be defined as the artificial application of water to land for the purposes of agriculture. It is, then, precisely the opposite of drainage, which is the artificial removal of water from lands which have become saturated, to the detriment of agriculture. A drain, like a river, goes on increasing as affluents join it. An irrigation channel goes on diminishing as water is drawn off it. Later on I shall show you how good irrigation should always be accompanied by drainage.

In lands where there is abundant rainfall, and where it falls at the right season of the year for the crop which it is intended to raise, there is evidently no need of irrigation. But it often happens that the soil and the climate are adapted for the cultivation of a more valuable crop than that which is actually raised, because the rain does not fall just when it is wanted, and there we must take to artificial measures.

In other lands there is so little rain that it is practically valueless for agriculture, and there are but two alternatives—irrigation or desert. It is in countries like these that irrigation has its highest triumph; nor are such lands always to be pitied or despised. The rainfall in Cairo is on an average 1·4 inches per annum, yet lands purely agricultural are sold in the neighbourhood as high as 150*l.* an acre.

This denotes a fertility perhaps unequalled in the case of any cultivation depending on rain alone, and this in spite of the fact that the Egyptian cultivator is in many respects very backward. The explanation is not far to seek. All rivers in flood carry along much more than water. Some carry alluvial matter. Some carry fine sand. Generally the deposit is a mixture of the two. I have never heard of any river that approached the Nile in the fertilising nature of the matter borne on its annual floods; with the result that the plains of Egypt have gone on through all ages, with the very minimum of help from foreign manures, yielding magnificent crops and never losing their fertility. Other rivers bring down little but barren sand, and any means of keeping it off the fields should be employed.

Primitive Means of Irrigation.

The earliest and simplest form of irrigation is effected by raising water from a lake, river, or well, and pouring it over the land. The water may be raised by any mechanical power, from the brawny arms of the peasant to the newest pattern of pump. The earliest Egyptian sculptures show water being raised by a bucket attached to one end of a long pole, turning on an axis with a heavy counterpoise at the other end. In Egypt this is termed a *shadoof*, and to this day, all along the Nile banks, from morning to night brown-skinned peasants may be seen watering their fields in precisely this way. Tier above tier they ply their work so as to raise water 15 or 16 feet on to their land. By this simple contrivance it is not possible to keep more than about 4 acres watered by one *shadoof*, so you may imagine what an army is required to irrigate a large surface. Another method, largely used by the natives of Northern India, is the shallow bucket suspended between two strings, held by men who thus bale up the water. A step higher is the water-wheel, with buckets or pots on an endless chain around it, worked by one or a pair of bullocks. This is a very ordinary method of raising the water throughout the East, where the water-wheel is of the rudest wooden construction and the pots are of rough earthenware. Yet another method of water-raising is very common in India from wells where the spring level may be as deep as 100 feet or more. A large leathern bag is let down the well by a rope passing over a pulley and raised by a pair of bullocks, which haul the bag up as they run down a slope the depth of the well. An industrious farmer with a good well and three pairs of good bullocks can keep as much as 12 acres irrigated in Northern India, although the average is much less there. The average cost of a masonry well in India varies from 20*l.* to 40*l.*, according to the depth required. But it is obvious that in many places the geological features of the country are such that well-sinking is impracticable. The most favourable conditions are found in the broad alluvial plains of a deltaic river, the subsoil of which may be counted on as containing a constant supply of water.

Pumps and Windmills.

All these are the primitive water-raising contrivances of the East. Egypt has of late been more in touch with Western civilisation, and since its cotton and sugar-cane crops yield from 6*l.* to 8*l.* or even 10*l.* per acre, the well-to-do farmer can easily afford a centrifugal pump worked by steam power. Of these there are now many hundreds, fixed or portable, working on the Nile banks of Egypt. Where wind can be counted on the windmill is a very useful and cheap means of raising water. But everything depends on the force and the trustworthiness of the wind. In the dry Western States of America wind power is largely used for pumping. It is found that this power is of little use if its velocity is not at least six miles per hour. (The mean force of the wind throughout the whole United States is eight miles per hour.) Every windmill, moreover, should discharge its water into a tank. It is evident that irrigation cannot go on without cessation day and night, and it may be that the mill is pumping its best just when irrigation is least wanted. The water should, therefore, be stored till required. In America it is found that pumping by wind power is about two-thirds of the cost of steam power. With a reservoir 5 to 15 acres may be kept irrigated by a windmill. Without a reservoir 3 acres is as much as should be counted on. Windmills attached to wells from 30 to 150 feet deep cost from 30*l.* to 70*l.*

Artesian Wells.

Up to now the artesian well cannot be counted on as of great value for irrigation. In the State of California there are said to be 8097 artesian wells, of a mean depth of 210 feet, discharge 0·12 cubic feet per second, and original cost on an average 50*l.* Thirteen acres per well is a large outturn.

In Algeria the French have bored more than 800 artesian wells, with a mean depth of 142 feet, and they are said to irrigate 50,000 acres. But these are scattered over a large area. Otherwise, the gathering ground would probably yield a much smaller supply to each well than it now does. In Queensland artesian wells are largely used for the water supply of cattle stations, but not for irrigation.

Well Irrigation.

It is evident that where water has to be raised on to the field there is an outlay of human or mechanical power which may be saved if it can be brought to flow over the fields by gravitation. But there is one practical advantage in irrigating with the water raised from one's own well or from a river. It is in the farmer's own hands. He can work his pump and flood his lands when he thinks best. He is independent of his neighbours, and can have no disputes with them as to when he may be able to get water and when it may be denied to him. In Eastern countries, where corruption is rife among the lower subordinates of government, the farmer who sticks to his well knows that he will not require to bribe anyone; and so it is that in India about 13 millions of acres, or 30 per cent. of the whole annual irrigation, is effected by wells. Government may see fit to make advances to enable the farmer to find his water and to purchase the machinery for raising it; or joint-stock companies may be formed with the same object. Beyond this all is in the hands of the landowner himself.

Canal Irrigation.

Irrigation on a large scale is best effected by diverting water from a river or lake into an artificial channel, and thence on to the fields. If the water surface of a river has a slope of 2 feet per mile, and a canal be drawn from it with a surface slope of 1 foot per mile, it is evident that at the end of a mile the water in the canal will be 1 foot higher than that in the river; and if the water in the river is 10 feet below the plain, at the end of 10 miles the water in the canal will be flush with the plain, and henceforth irrigation can be effected by simple gravitation.

When there is no question of fertilising deposit, and only pure water is to be had, the most favourable condition of

irrigation is where the canal or the river has its source of supply in a great lake. For, be the rainfall ever so heavy, the water surface in the lake will not rise very much, nor will it greatly sink at the end of a long drought. Where there is no moderating lake, a river fed from a glacier has a precious source of supply. The hotter the weather, the more rapidly will the ice melt, and this is just when irrigation is most wanted.

Elsewhere, if crops are to be raised and the rain cannot be counted on, nor well irrigation be practised, water storage becomes necessary, and it is with the help of water storage that in most countries irrigation is carried on.

Water Storage.

To one who has not given the subject attention, surprise is often expressed at the large volume of water that has to be stored to water an acre of land. In the case of rice irrigation in India, it is found that the storage of a million cubic feet does not suffice for more than from 6 to 8 acres. For the irrigation of wheat about one-third this quantity is enough. It would never pay to excavate on a level plain a hollow large enough to hold a million cubic feet of water. It is invariably done by throwing a dam across the bed of a river or a valley and ponding up the water behind it. Many points have here to be considered: the length of dam necessary, its height, the material of which it is to be constructed, the area and the value of the land that must be submerged, the area of the land that may be watered. The limits of the height of a dam are from about 150 to 15 feet. If the slope of the valley is great it may be that the volume which can be ponded up with a dam of even 150 feet is inconsiderable, and the cost may be prohibitory. On the other hand, if the country is very flat, it may be that a dam of only 20 feet high may require to be of quite an inordinate length, and compensation for the area of land to be submerged may become a very large item in the estimate. I have known of districts so flat that in order to irrigate an acre more than an acre must be drowned. This looks ridiculous, but is not really so, for the yield of an irrigated acre may be eight or ten times that of an unirrigated one; and after the storage reservoir has been emptied it is often possible to raise a good crop on the saturated bed.

The advantage of a deep reservoir is, however, very great, for the evaporation is in proportion to the area of the surface, and if two reservoirs contain the same volume of water, and the depth of one is double that of the other, the loss by evaporation from the shallow one will be double that of the deep one. In India, from time immemorial, it has been the practice to store water for irrigation, and there are many thousands of reservoirs, from the great artificial lakes holding as much as 5000 or 6000 millions of cubic feet, down to the humble village tank holding not a million. There are few of which the dam exceeds 80 feet in height, and such are nearly always built of masonry or concrete. For these it is absolutely necessary to have sound rock foundations. If the dam is to be of earth, the quality of the soil must be carefully seen to, and there should be a central core of puddle resting on rock and rising to the maximum height of water surface. If the dam is of masonry, there may perhaps be no harm done should the water spill over the top. If it is of earth, this must never happen, and a waste weir must be provided, if possible cut out of rock or built of the best masonry, and large enough to discharge the greatest possible flood. More accidents occur to reservoirs through the want of sufficient waste weirs or their faulty construction than from any other cause.

As important as the waste weir are the outlet sluices through which the water is conveyed for the irrigation of the fields. If possible they should be arranged to serve at the same time as scouring sluices to carry off the deposit that accumulates at the bottom of the reservoir. For, unless provided with very powerful scouring sluices, sooner or later the bed of the reservoir will become silted up, and the space available for water storage will keep diminishing. As this happens in India, it is usual to go on raising the embankment (for it does not pay to dig out the deposit), and so the life of a reservoir may be prolonged for many years. Ultimately it is abandoned, as it is cheaper to make a new reservoir altogether than to dig out the old one.

Italian Irrigation.

For the study of high-class irrigation there is probably no school so good as is to be found in the plains of Piedmont and Lombardy. Every variety of condition is to be found here. The engineering works are of a very high class, and from long generations of experience the farmer knows how best to use his water.

The great river Po has its rise in the foothills to the west of Piedmont. It is not fed from glaciers, but by rain and snow. It carries with it a considerable fertilising matter. Its temperature is higher than that of glacial water—a point to which much importance is attached for the very valuable meadow irrigation of winter. From the left bank of the Po, a few miles below Turin, the great Cavour Canal takes its rise, cutting right across the whole drainage of the country. It has a full-supply discharge of 3800 cubic feet per second; but it is only from October to May that it carries anything like this volume. In summer the discharge does not exceed 2200 cubic feet per second, which would greatly cripple the value of the work were it not that the glaciers of the Alps are melting then, and the great torrents of the Dora Baltea and Sesia can be counted on for a volume exceeding 6000 cubic feet per second.

Lombardy is in no respects worse off than Piedmont for the means of irrigation; and its canals have the advantage of being drawn from the lakes Maggiore and Como, exercising a moderating influence on the Ticino and Adda rivers, which is sadly wanted on the Dora Baltea. The Naviglio Grande of Lombardy is drawn from the left bank of the Ticino, and is used largely for navigation, as well as irrigation. It discharges between 3000 and 4000 cubic feet per second, and nowhere is irrigation probably carried on with less expense. From between Lake Maggiore and the head of the Naviglio Grande a great new canal, the Villoresi, has been constructed during the last few years with head sluices capable of admitting 6700 cubic feet per second, of which, however, 4200 cubic feet have to be passed on to the Naviglio Grande. Like the Cavour Canal, the Villoresi crosses all the drainage coming down from the foothills to the north. This must have entailed the construction of very costly works.

Irrigation in Northern India.

It is in India that irrigation on the largest scale is to be found. The great plains of Northern India are peculiarly well adapted for irrigation, which is a matter of life and death to a teeming population all too well accustomed to a failure of the rain supply.

The Ganges, the Jumna, and the great rivers of the Punjab have all been largely utilised for feeding irrigation canals. The greatest of these, derived from the river Chenab, and discharging from 10,500 to 3000 cubic feet per second, was begun in 1889, with the view of carrying water into a tract entirely desert and unpopulated. It was opened on a small scale in 1892, was then enlarged, and ten years after it irrigated in one year 1,829,000 acres, supporting a population of 800,000 inhabitants, colonists from more congested parts of India.

The Ganges Canal, opened in 1854, at a time when there was not a mile of railway, and hardly a steam engine within a thousand miles, has a length of about 9900 miles, including distributing channels. It was supplemented in 1878 by a lower canal, drawn from the same river 130 miles further down, and these two canals now irrigate between them 1,700,000 acres annually. On all these canals are engineering works of a very high class. The original Ganges Canal, with a width of bed of 200 feet, a depth of 10 feet, and a maximum discharge of 10,000 cubic feet per second, had to cross four great torrents before it could attain to the watershed of the country, after which it could begin to irrigate. Two of these torrents are passed over the canal by broad super-passages. Over one of them the canal is carried in a majestic aqueduct of fifteen arches, each of 50 feet span; and the fourth torrent, the most difficult of all to deal with, crosses the canal at the same level, a row of forty-seven floodgates, each 10 feet wide, allowing the torrent to pass through and out of the canal.

Elsewhere there are rivers in India, rising in districts subject to certain heavy periodical rainfall, and carrying their waters on to distant plains of very uncertain rainfall. At a small expense channels can sometimes be constructed drawing off from the flooded river water sufficient thoroughly to saturate the soil, and render it fit to be ploughed up and sown with wheat or barley, which do not require frequent watering. The canal soon dries up, and the sown crop must take its chance; but a timely shower of rain may come in to help it, or well irrigation may mature the crop. These, which are known in India as inundation canals, are of high value.

Southern India.

In Southern India there are three great rivers, drawing their supply from the line of hills called the Ghats, running parallel to and near the western coast, and after a long course discharging into the Bay of Bengal on the east coast. Against the Ghats beats the whole fury of the tropical S.W. monsoon, and these rivers for a few months are in high flood. As they approach the sea they spread out in the usual deltaic form. Dams have been built across the apex of these deltas, from which canals have been drawn, and the flood waters are easily diverted over the fields, raising a rice crop of untold value in a land where drought and famine are too common. But for the other months of the year these rivers contain very little water, and there is now a proposition for supplementing them with very large reservoirs.

A very bold and successful piece of irrigation engineering was carried out a few years ago in South India, which deserves notice. A river named the Periyar took its rise in the Ghats, and descended to the sea on the west coast, where there was no means of utilising the water, and a good deal of money had periodically to be spent in controlling its furious floods. A dam has now been built across its course, and a tunnel has been made through the mountains, enabling the reservoir to be discharged into a system of canals to the east, where there is a vast plain much in need of water.

In the native State of Mysore, in Southern India, there are on the register about 40,000 irrigation reservoirs (or tanks, as they are called), or about three to every four square miles, and the nature of the country is such that hundreds may be found in the basin of one river—small tanks in the upper branches and larger ones in the lower, as the valley widens out—and these require constant watchful attention. From time to time tropical rainstorms sweep over the country. If then even a small tank has been neglected, and rats and porcupines have been allowed to burrow in the dam, the flood may burst through it, and sweep on and over the dam of the next village, lower down. One dam may then burst after another, like a pack of cards, and terrible loss occurs.

In this State of Mysore a very remarkable irrigation reservoir is now under construction at a place called Mari Kanave. Nature seems here to have formed an ideal site for a reservoir, so that it is almost irresistible for the engineer to do his part, even although irrigation is not so badly wanted here as elsewhere. The comparatively narrow neck of a valley containing 2075 square miles is being closed by a masonry dam 142 feet high. The reservoir thus formed will contain 30,000 million cubic feet of water, but it is not considered that it will fill more than once in thirty years. Nor is there irrigable land requiring so great a volume of water. Much less would be sufficient, so such a high dam is not needed; but the construction of a waste weir to prevent the submergence of a lower dam would require such heavy excavation through one of the limiting hills that it is cheaper to raise the dam and utilise a natural hollow in the hillside for a waste weir.

Irrigation in Egypt.

No lecture on irrigation would be complete without describing what has been done in Egypt. You are generally familiar with the shape of that famous little country. Egypt proper extends northwards from a point in the Nile about 780 miles above Cairo—a long valley, never eight miles wide, sometimes not half a mile. East and west of this lies a country broken into hills and valleys, wild crags, level stretches, but everywhere absolutely sterile, dry sand and rock, at such a level that the Nile flood has never reached it to cover its nakedness with fertile deposit. A few miles north of Cairo the river bifurcates, and its two branches flow each for about 130 miles to the sea. As you are probably aware, with rivers in a deltaic state the tendency is for the slope of the country to be away from the river, and not towards it. In the Nile Valley the river banks are higher than the more distant lands. From an early period embankments were formed along each side of the river, high enough not to be topped by the highest flood. At right angles to these river embankments others were constructed, dividing the whole valley into a series of oblongs, surrounded on three sides by embankments, on the fourth by the desert heights. These oblong areas vary from about 50,000 to 3000 acres. I have said the slope of the valley is away from the river. It is easy, then, when the Nile is low, to cut short deep canals in the river banks, which fill as the river rises and carry the precious mud-charged water into these great flats. There the water remains for a month or more, some three or four feet deep, depositing its mud, and then at the end of the flood it may either be run off direct into the receding river, or cuts may be made in the cross embankments and the water passed off one flat after another, and finally rejoin the river. This takes place in November, when the river is rapidly falling. Whenever the flats are firm enough to allow a man to walk over them with a pair of bullocks, the mud is roughly turned over with a wooden plough, or even the branch of a tree, and wheat or barley is immediately sown. So soaked is the soil after the flood that the seed germinates, sprouts, and ripens in April without a drop of rain or any more irrigation, except what, perhaps, the owner may give from a shallow well dug in the field. In this manner was Egypt irrigated up to about a century ago. The high river banks which the flood could not cover were irrigated directly from the river, the water being raised as I have already described.

The Barrage.

With the last century, however, appeared a very striking figure in Egyptian history, Muhammed Ali Pasha, who came from Turkey a plain captain of infantry, and before many years had made himself master of the country, yielding only a very nominal respect to his suzerain lord, the Sultan at Constantinople.

Muhammed Ali soon recognised that with this flood system of irrigation only one cereal crop was raised in the year, while with such a climate and such a soil, with a teeming population and with the markets of Europe so near, something far more valuable might be raised. Cotton and sugar-cane would fetch far higher prices; but they could only be grown at a season when the Nile is low, and they must be watered at all seasons. The water-surface at low Nile is about 25 feet below the flood-surface, or more than 20 feet below the level of the country. A canal, then, running 12 feet deep in the flood would have its bed 13 feet above the low-water surface. Muhammed Ali ordered the canals in Lower Egypt to be deepened; but this was an enormous labour, and as they were badly laid out and graded they became full of mud during the flood and required to be dug out afresh. Muhammed Ali was then advised to raise the water-surface by erecting a dam (or, as the French called it, a *barrage*) across the apex of the delta, twelve miles north of Cairo, and the result was a very costly and imposing work, which it took long years and untold wealth to construct, and which was no sooner finished than it was condemned as useless.

Egyptian Irrigation since the English Occupation.

With the English occupation in 1883 came some English engineers from India, who, supported by the strong arm of Lord Cromer, soon changed the situation. The first object of their attention was the *barrage* at the head of the delta, which was made thoroughly sound in six years and capable of holding up 15 feet of water. Three great canals were taken from above it, from which a network of branches are taken, irrigating the province to the left of the western, or Rosetta branch of the river, the two provinces between the branches, and the two to the right of the eastern, or Damietta branch.

In Upper Egypt, with one very important exception (the Ibrahimieh Canal, which is a perennial one), the early flood system of irrigation, yielding one crop a year, prevailed until very recently, but it was immensely improved after the British occupation by the addition of a great number of masonry head sluices, aqueducts, escape weirs, &c., on which some 800,000*l.* was spent. With the completion of these works, and of a complete system of drainage, to be alluded to further on, it may be considered that the irrigation system of Egypt was put on a very satisfactory basis. There was not much more left to do, unless the volume of water at disposal could be increased.

Probably no large river in the world is so regular as the Nile in its periods of low supply and of flood. It rises steadily in June, July, and August. Then it begins to go down, at first rapidly, then slowly, till the following June. It is never a month before its time, never a month behind. It is subject to no exceptional floods from June to June. Where it enters Egypt the difference between maximum and minimum Nile is about 25 feet. If it rises $3\frac{1}{2}$ feet higher the country is in danger of serious flooding. If in former days its rise was 6 feet short of the average there existed a great risk that the floods would not cover the extensive flats of Upper Egypt, and thus the ground would remain as hard as stone, and sowing in November would be impossible. Fortunately the good work of the last twenty years very much diminishes this danger.

The Assuan Dam and Reservoir.

In average years the volume of water flowing past Cairo in September is from thirty-five to forty times the volume in June. By far the greater part of this flood flows out to the sea useless. How to catch and store this supply for use the following May and June was a problem early pressed on the English engineers in Egypt.

During the time of the highest flood the Nile carries along with it an immense amount of alluvial matter, and when it was first proposed to store the flood-water the danger seemed to be that the reservoir would in a few years be filled with deposit, as those I have described in India. Fortunately it was found that after November the water was fairly clear, and that if a commencement were made even as late as that there would still be water enough capable of being stored to do enormous benefit to the irrigation.

A site for a great dam was discovered at Assuan, 600 miles south of Cairo, where a dyke of granite rock crosses the valley of the river, occasioning what is known as the First Cataract. On this ridge of granite a stupendous work has now been created. A great wall of granite 6400 feet long has been thrown across the valley, 23 feet thick at the crest, 82 feet at the base. Its height above the rock-bed of the river is 130 feet. This great wall or dam holds up a depth of 66 feet of water, which forms a lake of more than 100 miles in length up the Nile Valley, containing 38,000 million cubic feet of water.

The dam is pierced with 180 sluices, or openings, through which the whole Nile flood, about 360,000 cubic feet per second, is discharged. A flight of four locks, each 260×30 feet, allows of free navigation past the dam. The foundation-stone of this great work was laid in February 1899, and it was completed in less than four years. At the same time a very important dam of the pattern of the barrage north of Cairo was built across the Nile at Assiut, just below the head of the Ibrahimieh Canal, not with the object of storing water, but to enable a requisite supply at all times to be sent down that canal.

The chief use of the great Assuan reservoir is to enable perennial irrigation, such as exists in Lower Egypt, to be substituted in Upper Egypt for the basin system of watering the land only through the Nile flood; that is, to enable two crops to be grown instead of one every year, and to enable cotton and sugar-cane to take the place of wheat and barley. But a great deal more had to be done in order to obtain the full beneficial result of the work. About 450,000 acres of basin irrigation are now being adapted for perennial irrigation. Many new canals have had to be dug, others to be deepened. Many new masonry works have had to be built. It is probable the works will be finished in 1908. There will then have been spent on the great dam at Assuan, the minor one at Assiut, and the new canals of distribution in Upper Egypt about six and a half millions sterling. For this sum the increase of land rental will be about 2,637,000*l.*, and its sale value will be increased by about 26,570,000*l.*

Drainage.

In the great irrigation systems which I have been describing, for a long time little or no attention was paid to drainage. It was taken for granted that the water would be absorbed or evaporated, and get away somehow without doing any harm. This may hold good for high-lying lands, but alongside of these are low-lying lands into which the irrigation water from above will percolate and produce waterlogging and marsh. Along with the irrigation channel should be constructed the drainage channel, and Sir W. Willcocks, than whom there is no better authority on this subject, recommends that the capacity of the drain should be one-third that of the canal. The two should be kept carefully apart—the canal following the ridges, the drain following the hollows of the country, and one in no case obstructing the other. This subject of drainage early occupied the attention of the English engineers in Egypt. In the last twenty years many hundred miles of drains have been excavated, some as large as 50 feet width of bed and 10 feet deep.

Irrigation in America.

If it is to Italy that we should look for highly finished irrigation works and careful water distribution, and to India and Egypt for widespreading tracts of watered land, it is to America that we naturally look for rapid progress and bold engineering. In the Western States of America there is a rainfall of less than 20 inches per annum, the consequence of which is a very rapid development of irrigation works. In 1889 the irrigation of these Western States amounted to 3,564,416 acres. In 1900 it amounted to 7,539,545 acres. Now it is at least 10,000,000 acres. The land in these States sells from 10*s.* to 1*l.* per acre if unirrigated. With irrigation the same land fetches 8*l.* 10*s.* per acre. The works are often rude and of a temporary nature, the extensive use of timber striking a foreigner from the Old World. Some of the American canals are on a large scale. The Idaho Company's canal discharges 2585 cubic feet, the Turlock Canal in California 1500 cubic feet, and the North Colorado Canal 2400 cubic feet per second. These canals have all been constructed by corporations or societies, in no case by Government. On an average it has cost about 32*s.* per acre to bring the water on to the land, and a water-rate is charged of from 2*l.* 8*s.* to 4*l.* per acre, the farmer paying in addition a rate of from 2*s.* to 10*s.* per acre annually for maintenance. Distributary channels of less than 5 feet wide cost less than 100*l.*, up to 10 feet wide about 150*l.* per mile.

The Introduction of Irrigation into a Country.

It is evident that there are many serious considerations to be taken into account before entering on any large project for irrigation. Statistics must be carefully collected of rainfall, of the sources of water supply available, and of the amount of that rainfall which it is possible to store and utilise. The water should be analysed if there is any danger of its being brackish. Its temperature should be ascertained. It should be considered what will be the effect of pouring water on the soil, for it is not always an unmixed benefit. A dry climate may be changed into a moist, and fever and ague may follow. In India there are large tracts of heavy black soil, which with the ordinary rainfall produce excellent crops nine years out of ten, and where irrigation would rather do harm than good. But in the tenth year the rains fail, and without artificial irrigation the soil will yield nothing. So terrible may be the misery caused by that tenth year of drought that even then it might pay a Government to enter on a scheme of irrigation. But it is evident that it might not pay a joint-stock company.

In all cases it is of the first importance to establish by law the principle that all rivers or streams above a certain size are national property, to be utilised for the good of

the nation. Even where there is no immediate intention of constructing irrigation works it is well to establish this principle. Otherwise vested rights may be allowed to spring up, which it may be necessary in after years to buy out at a heavy cost.

Modes of Distributing and Assessing Water.

Where the river is too inconsiderable to be proclaimed as national property, and where there is no question of spreading the water broadcast over the land, but of bestowing it with minute accuracy over small areas to rear valuable plants, such as fruit-trees, it may be very well left to local societies or to syndicates of farmers to manage their own affairs. Where irrigation is on a larger scale, and its administration is a matter of national importance, the control of the water requires the closest consideration, especially if, as is usually the case, the area which may be irrigated exceeds the volume of water available to irrigate it, and where the water is delivered to the fields by gravitation without the labour of raising it. It must be decided on what principle the farmer's right to the water is to be determined. Is he to obtain water in proportion to the area of his land which is irrigable? If part of the irrigable land is not yet cultivated, is some of the supply to be reserved for such land? Is he to pay in proportion to the area actually watered each crop, or to the area which he might water if he chose? Where the slope of the land is sufficient to allow the water to flow freely out of a sluice into the field channel, it is not difficult to measure the water discharged. Modules have been invented for this purpose, and the owner of the field may be required to pay for so many cubic feet of water delivered. The Government or the association owning the canal will then have nothing to do with the way in which the water is employed, and self-interest will force the farmer to exercise economy in flooding his land. But even then precautions must be taken to prevent him from keeping his sluice open when it should be shut.

In Italy and in America water is generally charged by the module; but in many cases, where the country is very flat, the water cannot fall with a free drop out of the sluice, and, as far as I know, no satisfactory module has yet been invented for delivering a constant discharge through a sluice when the head of water in the channel of supply is subject to variation. These are the conditions prevailing in the plains of Northern India, where there is a yearly area of canal irrigation of about six millions of acres. The cultivator pays not in proportion to the volume of water he uses, but on the area he waters every crop, the rate being higher or lower according as the nature of the crop demands more or less water.

The procedure of charging for water is, then, as follows: When the crop is nearly ripe the canal watchman, with the village accountant and the farmers interested, go over the fields with a Government official. The watchman points out a field which he says has been watered. The accountant, who has a map and field-book of the village, states the number and the area of the field and its cultivator. These are recorded along with the nature of the crop watered. If the cultivator denies that he has received water, evidence is heard and the case is settled. A bill is then made out for each cultivator, and the amount is recovered with the taxes.

This system is perfectly understood, and works fairly well in practice. But it is not a satisfactory one. It holds out no inducement to the cultivator to economise water, and it leaves the door open to a great deal of corruption among the canal watchmen and the subordinate revenue officials.

Government Control of Water Supply.

Where the subject agricultural population is unfitted for representative government it is best that the Government should construct and manage the irrigation, on rules carefully considered and rigorously enforced, through the agency of officers absolutely above suspicion of corruption or unfair dealing. Such is the condition in Egypt and in the British possessions in India. Objections to it are evident enough. Officials are apt to be formal and inelastic, and they are often far removed from any close touch with the cultivating classes. But they are impartial and just, and I know of no other system that has not still greater defects.

Even if the agricultural classes in India were much better educated than they are, it would still be best that the control of the irrigation should rest with the Government. By common consent it is the Government alone that rules the army. Now the irrigation works form a great army, of which the first duty is to fight the grim demon of famine. Their control ought, therefore, to rest with the Government; but the conditions are very different when the agricultural classes are well educated and well fitted to manage their own affairs.

Irrigation is too new and experimental in America for us to look there for a well-devised scheme of water control. The laws and rules on the subject vary in different States, and are often contradictory. It is better to look at the system evolved after long years in North Italy.

The Italian System.

I have already alluded to the great Cavour Canal in Piedmont. This fine work was constructed by a syndicate of English and French capitalists, to whom the Government gave a concession in 1862. Circumstances to which I need not allude ruined this company, and the Government, who already had acquired possession of many other irrigation works in Piedmont, took over the whole Cavour Canal in 1874, a property valued at above four millions sterling, and ever since the Government has administered it.

The chief interest of this administration centres on the Irrigation Association West of the Sesia,[1] an association that owes its existence to the great Count Cavour. It takes over from the Government the control of all the irrigation effected by the Cavour and other minor canals within a great triangle lying between the left bank of the Po and the right bank of the Sesia. The association purchases from the Government from 1250 to 1300 cubic feet per second. In addition to this it has the control of all the water belonging to private canals and private rights, which it purchases at a fixed rate. Altogether it distributes about 2275 cubic feet per second, and irrigates therewith about 141,000 acres, of which rice is the most important crop. The association has 14,000 members, and controls 9600 miles of distributary channels. In each parish is a council, or, as it is called, a *consorzio*, composed of all landowners who take water. Each *consorzio* elects one or two deputies, who form a sort of water-parliament. The deputies are elected for three years, and receive no salary. The assembly of deputies elects three committees—the direction-general, the committee of surveillance, and the council of arbitration. The first of these committees has to direct the whole distribution of the waters, to see to the conduct of the *employés*, &c. The committee of surveillance has to see that the direction-general does its duty. The council of arbitration, which consists of three members, has most important duties. To it may be referred every question connected with water-rates, all disputes between members of the association or between the association and its servants, all cases of breaches of rule or of discipline. It may punish by fines any member of the association found at fault, and the sentences it imposes are recognised as obligatory, and the offender's property may be sold up to carry them into effect. An appeal may be made within fifteen days from the decisions of this council of arbitration to the ordinary law courts, but so popular is the council that, as a matter of fact, such appeals are never made.

To effect the distribution of the water the area irrigated is divided into districts, in each of which there is an overseer in charge and a staff of guards to see to the opening and closing of the modules which deliver the water into the minor watercourses. In the November of each year each parish sends in to the direction-general an indent of the number of acres of each description of

1 See Mr. Elwood Mead's "Report on Irrigation in Northern Italy," Printed for the Department of Agriculture, Washington, 1904.

crop proposed to be watered in the following year. If the water is available the direction-general allots to each parish the number of modules necessary for this irrigation; but it may quite well happen that the parish may demand more than can be supplied, and may have to substitute a crop like wheat, requiring little water, for rice, which requires a great deal.

The Government executes and pays for all repairs on the main canals. It further executes, at the cost of the Irrigation Association, all repairs on the minor canals. The association, then, has no engineers in its employ, but a large staff of irrigators. The irrigation module employed in Piedmont is supposed to deliver 2·047 cubic feet per second. The Association West of the Sesia buys from the Government what water it requires at a rate fixed at 800 liras per module, or 15*l.* 12*s.* 7*d.* per cubic foot per second per annum.

The association distributes the water by module to each district, and the district by module to each parish. Inside the parish each farmer pays, according to the area he waters, a sum to cover all the cost of the maintenance of the irrigation system, and his share of the sum which the association has to pay to the Government. This sum varies from year to year according as the working expenses of the year increase or diminish.

I have already mentioned the recently constructed Villoresi Canal in Lombardy. This canal belongs to a company, to whom the Government has given large concessions. This company sells its water wholesale to four districts, each having its own secondary canal, the cubic metre per second, or 35·31 cubic feet per second, being the unit employed. These districts, again, retail the water to groups of farmers termed *comizios,* whose lands are watered by the same distributary channels, their unit being the litre, or 0·035 cubic foot, per second. Within the *comizio* the farmer pays according to the number of hours per week that he has had the full discharge of the module.

I have thought it worth while to describe at some length the systems employed on these Italian canals, for the Italian farmers set a very high example, in the loyal way in which they submit to regulations which there must at times be a great temptation to break. A sluice surreptitiously opened during a dark night, and allowed to run for six hours, may quite possibly double the value of the crop which it waters. It is not an easy matter to distribute water fairly and justly between a number of farms at different levels, dependent on different watercourses, cultivating different crops. But in Piedmont this is done with such success that an appeal from the council of arbitration to the ordinary law courts is unheard of. It is thought apparently as discreditable to appropriate an unfair supply of water as to steal a neighbour's horse, as discreditable to tamper with the lock of the water module as with the lock of a neighbour's barn.

Mr. Schuyler's Views as to Government Control.

Where such a high spirit of honour prevails I do not see why syndicates of farmers should not construct and maintain a good system of irrigation. Nevertheless, I believe it is better that Government should take the initiative in laying out and constructing the canals and secondary channels at least. A recent American author, Mr. James Dix Schuyler, has put on record: "That storage reservoirs are a necessary and indispensable adjunct to irrigation development, as well as to the utilisation of power, requires no argument to prove. That they will become more and more necessary to our Western civilisation is equally sure and certain; but the signs of the times seem to point to the inevitable necessity of Governmental control in their construction, ownership, and administration."

This opinion should not be disregarded. Sir W. Willcocks has truly remarked: "If private enterprise cannot succeed in irrigation works of magnitude in America, it will surely not succeed in any other country in this world." What its chances may be in South Africa I leave to my hearers to say. It is not a subject on which a stranger can form an opinion.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY A. C. HADDON, Sc.D., F.R.S., PRESIDENT OF THE SECTION.

THERE are various ways in which man can study himself, and it is clearly impossible for me to attempt to give an exposition of all the aims and methods of the anthropological sciences; I propose, therefore, to limit myself to a general view of South African ethnology, incidentally referring to a few of the problems that strike a European observer as needing further elucidation. It seems somewhat presumptuous in one who is now for the first time visiting this continent to venture to address a South African audience on local ethnology, but I share this disability with practically all students of anthropology at home, and my excuse lies in the desire that I may be able to point out to you some of the directions in which the information of anthropologists is deficient, with the hope that this may be remedied in the immediate future.

Men are naturally apt to take an exclusive interest in their immediate concerns, and even anthropologists are liable to fall into the danger of studying men's thoughts and deeds by themselves, without taking sufficient account of the outside influences that affect mankind.

In the sister science of zoology, it is possible to study animals as machines which are either at rest or in motion: when they are thus studied individually, the subjects are termed anatomy and physiology; when they are studied comparatively, they are known as comparative anatomy or morphology and comparative physiology. The study of the genesis of the machine is embryology, and palæontologists, as it were, turn over the scrap-heap. All these sciences can deal with animals irrespective of their environment, and perhaps for intensive study such a limitation is temporarily desirable, but during the period of greatest specialisation there have always been some who have followed in the footsteps of the field naturalist, and to-day we are witnessing a combination of the two lines of study.

Biology has ceased to be a mixture of necrology and physiology; it seeks to obtain a survey of all the conditions of existence, and to trace the effects of the environment on the organism, of the organism on the environment, and of organism upon organism. Much detailed work will always be necessary, and we shall never be able to do without isolated laboratory work; but the day is past when the amassing of detailed information will satisfy the demands of science. The leaders, at all events, will view the subject as a whole, and so direct individual labour that the hewers of wood and drawers of water, as it were, shall not mechanically amass material of which no immediate use can be made, but they will be so directed that all their energies can be exercised in solving definite problems or in filling up gaps in our information, with knowledge which is of real importance.

This tendency, which I have indicated as affecting the science of zoology, is merely one phase of an attitude of mind that is influencing many departments of thought. There are psychologists and theologians who deem it worth while to find out what other people think and believe. Arm-chair philosophers are awakening to the fact that their studies have hitherto been confined almost exclusively to the most highly specialised conditions, and that in order to comprehend these fully it is necessary to study the less and the yet less specialised conditions; for it is only possible to gain the true history of mind or belief by a combination of the observational with the comparative method. A considerable amount of information has already been acquired, but in most departments of human thought and belief vastly more information is needed, and hitherto the trustworthiness of a great deal that has been published is not above suspicion.

The comparative or evolutionary historian also needs trustworthy facts concerning the social condition of varied peoples in all stages of culture. The documentary records of history are too imperfect to enable the whole story to be unravelled, so recourse must be had to a study of analogous conditions elsewhere for side-lights which will cast illuminating beams into the dark corners of ancient history. When the historian seriously turns his attention

to the mass of data accumulated in books of travel, in records of expeditions, or the assorted material in the memoirs of students, he will doubtless be surprised to find how much there is that will be of service to him.

Sociologists have not neglected this field, but they need more information and more exhaustive and precise analyses of existing conditions. The available material is of such importance and interest, that the pleasure of the reader is apt to dull his critical faculty; as a matter of fact, the social conditions of extremely few peoples are accurately known, and sooner or later—generally sooner—the student finds his authorities failing him from lack of thoroughness.

I have alluded to the subjects of psychology, theology, history, and sociology, because they all overlap that area over which the anthropologist prowls. Indeed it is our work to collect, sift, and arrange the facts which may be utilised by our colleagues in these other branches of inquiry, and to this extent the ethnologist is also a psychologist, a theologian, a historian, and a sociologist.

Similarly the anthropographer provides material for the biologist on the one hand, and for the geographer on the other.

As a general rule those who have investigated any given people in the field have alluded to the general features of the country they inhabit, so that usually it is possible to gain some conception of them in their natural surroundings. Thus, to a certain extent, materials are available for tracing that interaction between life and environment and between organisms themselves, to which the term Œcology is now frequently applied, but we still need to have this interdependence more recognised in such branches of inquiry as descriptive sociology or religion.

Just as the arts and crafts of a people are influenced by their environment, so is their social life similarly affected, and their religion reflects the stage of social culture to which they have attained; for it must never be overlooked that the religious conceptions of a people cannot be thoroughly understood apart from their social, cultural, and physical conditions.

This may appear a trite remark, but I would like to emphasise the fact that very careful and detailed studies of definite or limited areas are urgently needed, rather than a general description of a number of peoples which does not exhaust any one of them—in a word, what we now need is thoroughness.

Three main groups of indigenous peoples inhabit South Africa—the Bushmen, the Hottentots, and various Bantu tribes; in more northerly parts of the continent there are the Negrilloes, commonly spoken of as Pygmies, the Negroes proper, and Hamitic peoples, not to speak of Arab and Semitic elements.

Kattea.

Before proceeding further I must here make allusion to an obscure race who may possibly be the true aborigines of Africa south of the Zambesi. These are the Kattea—or Vaalpens, as they are nicknamed by the Boers, on account of the dusty colour their abdomen acquires from the habit of creeping into their holes in the ground—who live in the steppe region of the North Transvaal, as far as the Limpopo. As their complexion is almost a pitch-black, and their stature only about 1·220 m. (4 ft.), they are quite distinct from their tall Bantu neighbours and from the yellowish Bushmen. The "Dogs," or "Vultures," as the Zulus call them, are the "lowest of the low," being undoubtedly cannibals and often making a meal of their own aged and infirm, which the Bushmen never do. Their habitations are holes in the ground, rock shelters, and lately a few hovels. They have no arts or industries, nor even any weapons except those obtained in exchange for ostrich feathers, skins, or ivory. Whether they have any religious ideas it is impossible to say, all intercourse being restricted to barter carried on in a gesture language, for nobody has ever yet mastered their tongue, all that is known of their language being that it is absolutely distinct from that of both the Bushman and the Bantu. There are no tribes, merely little family groups of from thirty to fifty individuals, each of which is presided over by a headman, whose functions are acquired, not by heredity, but by personal qualities. I have compiled this account of this most interesting people from Prof. A. H. Keane's book, "The Boer States," in the hope that a serious effort will be made to investigate what appears to be the most primitive race of all mankind. So little information is available concerning the Kattea that it is impossible to say anything about their racial affinities.

Perhaps these are the people referred to by Stow (p. 40), and possibly allied to these are the dwarfs on the Nosop River mentioned by Anderson; these were 1·125 m. (4 ft. 4 in.) or less in height, of a reddish-brown colour, with no forehead and a projecting mouth; Anderson's Masara Bushmen repudiated any suggestion of relationship with them, saying they were "monkeys, not men."

Bushmen.

The San, or Bushmen (Bosjesman of colonial annals), may, with the possible exception of the Kattea, be regarded as the most primitive of the present inhabitants of South Africa; according to most authors, there is no decisive evidence that there was an earlier aboriginal population, although M. G. Bertin informs us that Bushman tales always speak of previous inhabitants.

The main physical characteristics of the Bushmen are a yellow skin, and very short, black, woolly hair, which becomes rolled up into little knots; although of quite short stature, with an average height of 1·529 m. (5 ft. 0¼ in.), or, according to Schinz, 1·570 m. (5 ft. 1⅘ in.), they are above the pygmy limit of 1·450 m. (4 ft. 9 in.). The very small skull is not particularly narrow, being what is termed sub-dolichocephalic, with an index of about 75, and it is markedly low in the crown; the face is straight, with prominent cheekbones and a bulging forehead; the nose is extremely broad—indeed, the Bushmen are the most platyrrhine of all mankind; the ear has an unusual form, and is without the lobe. Their hands and feet are remarkably small.

Being nomadic hunters the Bushmen could only attain to the rudiments of material culture. The dwellings were portable, mat-covered, dome-shaped huts, but they often lived in caves; the Zulus say "their village is where they kill game; they consume the whole of it and go away." Clothing consisted solely of a small skin; for weapons they had small bows and poisoned arrows. Their only implement was a perforated rounded stone into which a stick was inserted; this was used for digging up roots. A very little coarse pottery was occasionally made. Although with a great dearth of personal ornaments, they had a fair amount of pictorial skill, and were fond of decorating their rock shelters with spirited coloured representations of men and animals. They frequently cut off the terminal joint of a little finger. They never were cannibals. Cairns of stones were erected over graves. Although they are generally credited with being vindictive, passionate, and cruel, they were as a matter of fact always friendly and hospitable to strangers until dispossessed of their hunting grounds. They did not fight one another, but were an unselfish, merry, cheerful race with an intense love of freedom.

A great mass of unworked material exists for the elucidation of the religious ideas, legends, customs, and so forth, of the Bushmen, in the voluminous native texts, filling eighty-four volumes, to the collection of which the late Dr. Bleek devoted his laborious life. This wonderful collection of the folklore of one of the most interesting of peoples still remains inaccessible to students in the Grey Library in Cape Town. A more enlightened policy in the past would have enabled Dr. Bleek to publish his own material; now the task is complicated by the great difficulty of finding competent translators and of securing the services of trustworthy natives who know their own folklore. The time during which this labour can be adequately accomplished is fleeting rapidly, and once more the Government must be urged to complete and publish the life-work of this devoted scholar.

The Mañanja natives, who live south of Lake Shirwa, assert that formerly there lived on the upper plateau of the mountain mass of Mlanje a people they call Arungu, or "gods," who from their description must have been Bushmen. Relics of Bushman occupation have been found in the neighbourhood of Lakes Nyassa and Tanganyika.

West of the Arangi plateau in German East Africa, between the steppes occupied by the Wanyamwezi and the Masai, live the Wasandawi, a settled hunting people who, according to Baumann, are very different from the surrounding Bantu peoples, and who are allied to the more primitive, wandering, hunting Wanege, or Watindiga, of the steppes near Usukuma. They use the bow and poisoned arrow. Their language, radically distinct from Bantu, is full of those strange click sounds which are characteristic of Bushman speech; but Sir Harry Johnston says that he does not know if any actual relationship has been pointed out in the vocabulary, and he distinctly states that the Sandawi are not particularly like the Bushmen in their physique, but more resemble the Nandi; and Virchow declares there is no relationship between the Wasandawi and the Hottentot in skull-form. Until further evidence is collected, one can only say that there may have been a Bushman people here who have become greatly modified by intermixture with other races. Sir Harry Johnston thinks that possibly traces of these people still exist among the flat-faced, dwarfish Doko, who live to the north of Lake Stephanie, and he is inclined to think that traces of them occur also among the Andorobo and Elgunono.

If the foregoing evidence should prove to be trustworthy, it would seem that at a very early time the Bushmen occupied the hunting grounds of tropical East Africa, perhaps even to the confines of Abyssinia. They gradually passed southwards, keeping along the more open grass lands of the eastern mountainous zone, where they could still preserve their hunting method of life, until, at the dawn of history, they roamed over all the territory south of the Zambesi, with the exception of the eastern seaboard.

Negrilloes.

Material does not at present exist for an exhaustive discussion of the exact relationship between the Bushmen and the Negrilloes of the Equatorial forests. On the whole I am inclined to agree with Sir Harry Johnston, who says: "I can see no physical features other than dwarfishness which are obviously peculiar to both Bushmen and Congo Pygmies. On the contrary, in the large and often protuberant eyes, the broad flat nose with its exaggerated alæ, the long upper lip and but slight degree of eversion of the inner mucous surface of the lips, the abundant hair on head and body, relative absence of wrinkles, of steatopygy, and of high protruding cheekbones, the Congo dwarf differs markedly from the Hottentot-Bushman type." Shrubsall had previously stated: "For the present I can only say that the data seem to me too insufficient to enable the affinities of the various pygmy races to be clearly demonstrated, or to allow of much significance being attached to any apparent resemblance." Deniker also directs attention to the physical characters that distinguish those two types, and he concludes that "nothing justifies their unification."

Hottentots.

The skin of the Hottentots, or Khoikhoi, as they style themselves, is of a brownish-yellow, with a tinge of grey, sometimes of red; the hair is very similar to that of the Bushmen; the average stature is 1·604 m. (5 ft. 3 in.); the head is small and distinctly dolichocephalic (74), the jaws prognathic, cheekbones prominent, and chin small. Shrubsall, who has investigated the osteological evidence, says no hard-and-fast line can be drawn from craniological evidence between Hottentots and Bushmen on the one hand and Negroid races on the other, various transitional forms being found; but Bushman characteristics undoubtedly predominate in the true Hottentots.

The Hottentots were grouped in clans, each with its hereditary chief, whose authority, however, was very limited. Several clans were loosely united to form tribes. Their principal property consisted of horned cattle and sheep; the former were very skilfully trained. The dwellings were portable, mat-covered, dome-shaped huts. For weapons they had a feeble bow with poisoned arrows, but they also had assegais and knobkerries or clubbed sticks used as missiles; coarse pottery was made. They were often described as mild and amiable.

The Hottentot migration from the eastern mountainous zone took place very much later than that of the Bushmen, and it seems to have been due mainly to the pressure from behind of the waxing Bantu peoples. These pastoral nomads took a south-westerly course across the savanna country, and if the tsetse fly had the same distribution then as now they probably, more or less, followed the right bank of the Zambesi, then struck across to the Kunene north of the desert land, and worked their way down the west coast and along the southern shore of the continent.

What is now Cape Colony was inhabited solely by Bushmen and Hottentots at the time of the arrival of the Europeans. As the latter expanded they drove the aborigines before them, but in the meantime mongrel peoples had arisen, mainly of Boer-Hottentot parentage, who also were forced to migrate. Those of the Cape Hottentots who were not exterminated or enslaved drifted north and found in Bushman Land an asylum from their pursuers. The north-east division of the Hottentots comprises the Koranna, or Goraqua; they were an important people, despite the fact that they had no permanent home. They migrated along the Orange River—one section went up the right bank of the Harts and the other went up the Vaal until they were deflected by the Bechuana. When the Boers in 1858 were engaged with the Basuto, the Koranna devastated the Orange Free State, but were themselves ultimately destroyed. The original home of the Griqua was in the neighbourhood of the Olifant River; in the middle of the eighteenth century the colonists settled in the land, and as a result the Griqua-Bastards retreated to the east under the leadership of the talented Adam and Cornelius Kok. They adopted the name Griqua in place of the earlier one of Bastard; one split founded Griqua Town in Griqualand West, but the other went further east and eventually settled east of the Drakensberg, between Natal and Basutoland, and occupied the country devastated by Chaka's wars. Here rose the chief town, Kokstadt, in Griqualand East, where a few Griqua still live. The interesting little nation of the Bastards, descendants of unions between Europeans, mostly Boers, and Hottentot women, now mixes very little with other peoples. They were forced in 1868 to leave their home in Great Bushmanland owing to the ravages of Bushmen and Koranna, and finally, after various wanderings and vicissitudes, they settled as four communities in Great Namaqualand, in German territory. Namaqualand is too infertile to attract colonists, and thus it forms an asylum for expatriated Hottentots as well as for the Namaqua division of the Hottentots, the original inhabitants of the country.

True Negroes.

One of the most primitive populations of Africa is that of the true, or West Africa, Negroes. At present this element is mainly confined to the Sudan and the Guinea Coast.

The main physical characteristics of the true Negro are: "black" skin, woolly hair, tall stature, averaging about 1·730 m. (5 ft. 8 in.), moderate dolichocephaly, with an average cephalic index of 74–75. Flat, broad nose, thick and often everted lips, frequent prognathism.

West African culture contains some characteristic features. The natives build gable-roofed huts; their weapons include spears with socketed heads, bows tapering at each end with bowstrings of vegetable products, swords and plaited shields, but no clubs or slings. Among the musical instruments are wooden drums and a peculiar form of guitar, in which each string has its own support. Clothing is of bark-cloth and palm-fibre, and there is a notable preponderance of vegetable ornaments. Circumcision is common and the knocking out of the upper incisors. With regard to religion, there is a great development of fetishism and incipient polytheistic systems. Colonel Ellis has proved in a masterly manner the gradual evolution of religion from west to east along the Guinea Coast, and this is associated with an analogous progress in the laws of descent and succession to property, and in the rise of government. He further suggests that differences in the physical character of each country in question have played a great part in this progressive evolution. Here also are to be found secret societies, masks and representations of human figures. The ordeal by poison is employed, chiefly for the discovery of witchcraft; anthro-

pophagy occurs. The domestic animals are the dog, goat, pig, and hen. Cattle are absent owing to the tsetse fly. The plants originally cultivated were beans, gourds, bananas, and perhaps earth-nuts. Coiled basketry and head-rests are absent.

That branch of the true Negro stock which spake the mother-tongue of the Bantu languages some 3000 years ago (according to Sir Harry Johnston's estimate) spread over the area of what is now Uganda and British East Africa. In the Nile valley these people probably mixed with Negrilloes, and possibly with the most northerly representatives of the Bushmen in the high lands to the east. Here also they came into contact with Hamitic peoples coming down from the north, and their amalgamation constituted a new breed of Negro—the Bantu. We have already seen what are some of the more important physical characteristics of the Negro, Negrillo, and Bushman stocks; it only remains to note in what particulars they were modified by the new blood.

Hamites.

The Hamites are to be regarded as the true indigenous element in North Africa, from Morocco to Somaliland. Two main divisions of this stock are generally recognised: (1) the Northern or Western Hamites (or Mediterranean race of some authors), of which the purest examples are perhaps to be found among the Berbers; and (2) the Eastern Hamites or Ethiopians. These two groups shade into each other, and everywhere a Negro admixture has taken place to a variable extent since very early times. The Hamites are characterised by a skin-colour that varies considerably, being white in the west and various shades of coffee-brown, red-brown, or chocolate in the east; the hair is naturally straight or curly, but usually frizzly in the east. The stature is medium or tall, averaging about 1·670 m. (5 ft. 5¾ in.) to about 1·708 m. (5 ft. 7¼ in.); the head is sub-dolichocephalic (75–78); the face is elongated and the profile not prognathous; the nose prominent, thin, straight or aquiline, with narrow nostrils; lips thin or slightly tumid, never everted.

Bantu.

Roughly speaking, the whole of Africa south of the equator, with the exception of the dwindling Bushman and Hottentot elements, is inhabited by Bantu-speaking peoples, who are extremely heterogeneous, but who exhibit sufficient similarities in physical and cultural characteristics to warrant their being grouped together: the true Negro may be regarded as a race; the Bantu are mixed peoples.

It will be noticed that as a rule the Bantu approach the Hamites in those physical characters in which they differ from the true Negroes, and owing to the fact that the physical characters of Semites in the main resemble those of Hamites, any Semitic mixture that may have taken place will tend in the same direction as that of the Hamitic. The diversity in the physical characters of the Bantu is due to the different proportions of mixture of all the races of Africa. What we now require is a thorough investigation of these several elements in as pure a state as possible, and then by studying the various main groups of Bantu peoples their relative amount of racial mixture can be determined.

The physical characteristics of the Bantu vary very considerably. The skin colour is said to range from yellowish-brown to dull slatey-brown, a dark chocolate colour being the prevalent hue. The character of the hair calls for no special remark, as it is so uniformly of the ordinary Negro type. The stature ranges from an average of about 1·640 m. (5 ft. 4½ in.) to about 1·715 m. (5 ft. 7½ in.). Uniformity rather than diversity of head-form would seem to be the great characteristic of the African black races, but a broad-headed element makes itself felt in the population of the forest zone and of some of the upper waters of the Nile Valley. It appears that the broadening of the head is due to mixture with the brachycephalic Negrillo stock, for, whereas the dolichocephals are mainly of tall stature, some of the brachycephals, especially the Aduma of the Ogowe, with a cephalic index of 80·8, are quite short, 1·594 m. (5 ft. 2¾ in.). The character of the nose is often very useful in discriminating between races in a mixed population, but it has not yet been sufficiently studied in Africa, where it will probably prove of considerable value, especially in the determination of the amount of Hamitic or Semitic blood. The results already obtained in Uganda are most promising. Steatopygy is not notable among men; fatty deposits are well developed among women, but nothing approaching the extent characteristic of the Hottentots and Bushmen.

It appears that the Bantu peoples may be roughly divided according to culture into two groups: a western zone, which skirts the West African region and extends through Angola and German West Africa into Cape Colony; and an eastern zone. (1) The western Bantu zone is characterised by beehive huts, the absence of circumcision, and the presence of wooden shields (plain or covered with cane-work) in its northern portion, though skin shields occur to the south. (2) In the eastern Bantu zone the huts are cylindrical, with a separate conical roof.

Certain characteristics are typical of the Bantu culture. The natives live in rounded huts with pointed roofs; their weapons comprise spears, in which the head is fastened into the shaft by a spike, bows of equal thickness along their length, with bowstrings of animal products, clubs and skin shields, but slings are usually absent; the clothing is of skin and leather, and there is a predominance of animal ornaments; knocking out the lower incisors is general, circumcision is common, though among the Kafir tribes it seems to be dying out; ancestor-worship is the prevalent form of religion, fetishism and polytheism are undeveloped; masks and representations of human figures are rare, and there are no secret societies; anthropophagy is sporadic and usually temporary; the domestic animals include the dog, goat, and sheep, and cattle are found wherever possible; coiled basketry is made, and head-rests are a characteristic feature.

M. A. de Préville has drawn a broad line of distinction between the religion of the pastoral Bantu tribes and that of the hunters of the forest belt. The cattle-raisers of the small pastures recognise that the rain and necessary moisture depend on an invisible and supreme power whom they invoke in his location in the sky. His intermediaries are the rain-makers, he has no human form, neither are there idols in the pantheon. In Central Africa there is more than sufficient rain, but rain is of little importance to the hunter. What he requires is to find game, to be able to capture it and to avoid danger; the "medicine-men" are not rain-makers, but makers of talismans, amulets, philtres, and charms to attract the game and to ensure its capture. The mysterious depths of the forest, in the impenetrable thickets of which death may lurk at each step, and the isolation which results in social disorganisation, incline the hunter to superstitious terrors. Pasturage is governed by natural impersonal forces, but hunting is individual and personal. Further, associated with the mobile pastoral life of the Bantu is the patriarchal system of family life, respect and veneration for old age, and the autocracy of the chief; no wonder, then, that ancestor-worship has developed, or that it is the chief factor in the religious life of these people.

As I have previously indicated, there is evidence of the former extension to the north of the Hottentots and the Bushmen, they having gradually been pressed first southwards and then into the steppes and deserts of South Africa by the southerly drifting of the Bantu.

The mixture of Hamite with Negro, which gave rise to the primitive Bantu stock, may have originated somewhere to the east or north-east of the Victoria Nyanza. A factor of great importance in the evolution of the Bantu is to be found in the great diversity of climate and soil in Equatorial East Africa. It is a country of small plateaux separated by gorges, or low-lying lands. The small plateaux are suitable for pasturage, but their extent is limited; thus they fell to the lot of the more vigorous people, while the conquered had to content themselves with low country, and were obliged to hunt or cultivate the land. In these healthy highlands the people multiplied, and migration became necessary; the stronger and better-organised groups retained their flocks and migrated in a southerly direction, keeping to the savannas and open country, the line of least resistance being indicated by the relative social feebleness of the peoples to the south. In the small plateaux a nomadic life is impossible for the

herders: there being at most a seasonal change of pasturage, this prevents the possession of large herds and necessitates a certain amount of tillage; further, it would seem that this mode of life tends to develop military organisation and a tribal system.

No materials at present exist for any attempt at a history of this stage of the Bantu expansion, but from what we know of the great folk-wanderings in South Africa during the first half of the nineteenth century, we can form some estimate of what may have happened earlier in Equatorial Africa.

Lichtenstein lived among the Bechuanas in 1805, and from that date begins our knowledge of the Bantu peoples. Dr. G. M. Theal, the learned historian of South Africa, Dr. K. Barthel and Mr. G. W. Stow, whose valuable book has just appeared, have made most careful studies of folk-wanderings in South Africa, based upon the records of the explorers of the past hundred years; we scarcely have trustworthy accounts of the movements of the various tribes for a longer period, and oral traditions of the natives, though in the main correct, require careful handling. The nature of the country is such that it affords more than ordinary facilities for migrations, and the absence of great geographical barriers prevents ethnical differentiation.

The Bantu peoples of Southern Africa may conveniently be classified in three main groups:—

(1) The eastern tribes, composed of the Zulu-Xosa.

(2) The interior tribes, consisting of the Bechuana, Basuto, Mashona, &c.

(3) The western tribes, such as the Ovampo and Ovaherero.

(1) The Zulu-Xosa are respectively the northern and southern branches of a migration down the east coast, that, according to some authorities, took place about the fifteenth century. The Amaxosa (Kosa, or Kafirs) never overstepped the Drakensberg range, but there have been northerly and, more especially, southerly movements: the Amaxosa, for example, extended, about 1800, as far as Kaaimans River, Mossel Bay, but in 1835 they were pressed back by the colonists to the Great Fish River.

The Amazulu have occupied the east coast, north of the Tugela, for a long period, and allied tribes extend as far as the Zambesi; indeed, it may be said that a complete chain of Zulu peoples stretches up to the neighbourhood of the equator, the more open country in which they live giving greater opportunities for expansion. The wonderful rise to power of Chaka (1783–1828) caused great movements of peoples to take place. The Amangwane (who drove the Amahlubi before them) and other groups fled southward to escape from the tyranny of this great warrior. The conquerors applied to these scattered remnants of tribes the contemptuous term "Fingu," or homeless fugitives, and turned them into slaves and cattle-tenders. The Matabele, to the number of some 60,000 individuals, separated from the parent stock about 1817, under the leadership of the terrible Moselekatze (Umsilikatzi), whose fame as an exterminator of men ranks second only to that of Chaka; they crossed the Drakensberg and went north-west through the Transvaal, scattering the settled Bechuana peoples. They were attacked by the Boers, who defeated them with terrible slaughter, from which only forty warriors escaped. They withdrew to the Zambesi, but were driven south by the tsetse fly. They encountered the Makalaka and destroyed their villages, drove out the Mashona to the north-east, and settled in Mashonaland.

(2) The great central region of the South African plateau, roughly known as Bechuanaland, was very early occupied by Bantu peoples coming from the north, who displaced or reduced to servitude the indigenous Bushmen. As Prof. Keane points out, the Bechuana must have crossed the Zambesi from the north at a very early date, because of all the south Bantu groups they alone have preserved the totemic system. Among the first to arrive, according to him, appear to have been the industrious Mashona and Makalaka. For three hundred years, according to native tradition, the Makalaka owned the land between the Limpopo and the Zambesi, and then came the Barotse, who are allied to the Congo Bantu, and conquered them. A section of the latter founded a powerful so-called Barotse (Marotse) empire on the Middle Zambesi above the Victoria Falls. At the beginning of the nineteenth century a Bahurutse dynasty ruled over the Bechuana; as these people expanded they broke off into clans, and extended between the Orange River and the Zambesi, and from the Kathlamba, or Drakensberg chain, to the Kalahari Desert.

The densely populated country west of the Drakensberg now known as Basutoland was subjected to great devastation as a result of Chaka's tyranny. In 1822 a tribe fleeing from the Zulus set up the first of these disturbances, and the attacked became the attackers in their turn. One horde, the Mantati, achieved great notoriety, and are credited with having wiped out twenty-eight tribes; they were eventually defeated by the Bangwaketsi and scattered by the Griqua. The Makololo, a small group of the Mantati (who lived on the upper waters of the Orange River), led by Sebituane, in 1823 aimed at reaching the district of the Chobe and Zambesi, where he had heard that it was always spring. After conquering the Bakwena, Bahurutse, and other kindred tribes and increasing their forces from the conquered peoples, they crossed the Zambesi and the uplands stretching to the Kafukwe, and settled in those fertile pasture lands about 1835. Disturbed by the Matabele, Sebituane passed through the Barotse Valley, followed by the Matabele and the Batoka, a tribe of the Barotse. He put the former to flight and subjugated the latter. Thus Sebituane led his people a journey of more than 2000 miles to reach their Promised Land. Under Sekeletu, Sebituane's successor, the State began to fall to pieces, and after his death the Barotse revolted, and practically exterminated the Makololo. The rehabilitated Barotse empire comprises an area of some 250,000 square miles between the Chobe and Kafukwe affluents of the Zambesi. Prof. Keane directs attention to the instructive fact that though the Makololo have perished from among the number of South African tribes, their short rule (1835–1870) was long enough to impose their language upon the Barotse, and to this day, about the Middle Zambesi, where the Makololo have disappeared, their speech remains the common medium of intercourse throughout the Barotse empire. The consolidation of the Basuto under the astute Moshesh is an instructive episode in the history of the South African races. The Bamangwato are the most important branch of the independent Bechuana peoples, who have made considerable progress under the wise guidance of the enlightened Khama; they are an industrious people, and have exceptional skill in working iron.

According to Mr. G. W. Stow there were three main migrations of the interior, or middle, Bantu, or Bachoana as he terms them: (i.) The pioneer tribes of the southward migration into the ancient Bushman hunting grounds were the Leghoya, Bakalahari, and those who intermarried with the Bushmen to form the Balala and Bachoana Bushmen; (ii.) the tribes of the second period of the Bachoana migration were the Batlapin and Barolong; (iii.) the great Bakuena or Bakone tribes were the most civilised of the Bantu peoples: they consisted of the Bahurutse, Batlaru, Bamangwato, Batauana, Bangwaketse, and the Bakuena, who were the wealthiest and most advanced of all until they were reduced by the Mantati and destroyed by the Matabele.

(3) Turning for a moment to German South-West Africa we find the Bastards to the south, and north of them the Haukoin or Mountain Damara, who are now practically a pariah people, subject to the Hottentots, Bastards, Ovaherero, and the white man. It is possible that these are of Negro rather than of Bantu origin; in mode of life, save for their talent for agriculture, they are Bushmen; in their speech they are Hottentots, but their colour is darker than that of their neighbours. Somewhere from Eastern South Africa, about a hundred years ago, came the Ovaherero, or the Merry People, who, like the rest of the Bantu, are warlike cattle-breeders, with wandering proclivities, but they are not agriculturists. When they arrived in the Kaoko district they drove the Haukoin to the south, together with the Toppnaers (Aunin) and Bushmen. To the north of the Ovaherero are the agricultural Ovampo.

Speaking generally, the direction of ethnic migration in South Africa has been southerly in the south-east: the sea blocked an eastern expansion and the Drakensberg a western; only the Matabele went westward of this range to the north. In the central district the Bahurutse or Bechuana parent stock dispersed in various directions; most of the movements were towards the north, but the Mantati and Basuto went south-east. In the west the Cape Hottentots always retreated from the colonists towards the north; the Bastards and other tribes followed the same direction, the causes, as Barthel points out, being obvious: to the east is the Kalahari, on the west is the sea, from the south came the pressure of the Boers. Finally, right across South Africa we have, from west to east, the Koranna, Griqua, and Boer wanderings in the south; and in the north, from east to west, the wanderings of the Hottentots, Ovaherero, and of the Boer emigrants from the Transvaal.

South Africa has thus been a whirlpool of moving humanity. In this brief summary I have been able to indicate only the main streams of movement: there have been innumerable cross-currents which add complexity to this bewildering history, and much patient work is necessary before all these complications can be unravelled and their meaning explained.

When one takes a bird's-eye view of the ethnology of South Africa, certain main sociological facts loom out amongst all the wealth of varied detail.

The earliest inhabitants of whom we have any definite information were the dwarf Bushmen, who undoubtedly represent a primitive variety of mankind. In a land abounding with game they devoted themselves entirely to the chase, supplementing their diet with fruit and roots. This mode of life necessitates nomadic habits, the absence of property entails the impossibility of gaining wealth, and thereby relieving part of the population from the daily need of procuring food; this absence of leisure precludes the elaboration of the arts of life. A common effect of the nomadic hunting life is the breaking-up of the community into small groups; the boys can soon catch their own game, hence individualism triumphs and parental authority is apt to be limited. Social control is likely to be feeble unless the religious sentiment is developed, and certainly social organisation will be very weak. In an open country abounding with game the case is somewhat different, and there is reason to believe that in early days the Bushmen were divided into a number of large tribes, occupying tolerably well-defined tracts of country, each being under the jurisdiction of a paramount chief. The tribes were subdivided into groups under captains. They showed great attachment and loyalty to their chiefs, and exhibited a passionate love for their country. For hundreds of years these poor people have been harried and their hunting grounds taken away from them, and hence we must not judge the race by the miserable anarchic remnant that still persists in waste place. Nomad hunters do not progress far in civilisation by their own efforts, nor are they readily amenable to enforced processes of civilisation. Invariably they are pushed on one side or exterminated by peoples higher in the social scale.

When the written history of South Africa begins we find the Bushmen already being encroached upon by tbe Hottentots, who themselves sprang from a very early cross of Bantu with Bushmen. Culturally, as well as physically, they may be regarded as a blend of these two stocks. They combined the cattle-rearing habits of the Bantu with the aversion from tillage of the soil characteristic of the hunter; they became nomadic herders, who were stronger than the Bushmen, but who themselves could not withstand the Bantu when they came in contact with them, and they too were driven to less favourable lands and became enslaved by the invaders. All gradations of mixture took place until lusty uncontaminated Bantu folk forced their way into the most desirable districts. Still less could the Hottentots prevail against the colonists; their improvidence was increased by alcohol, and their indifference to the possession of land, due to their inherent love of wandering, completed their ruin.

The Bantu were cattle-rearers who practised agriculture. The former industry probably was transmitted from their Hamitic forefathers, who were herdsmen on the grassy uplands of north-eastern Africa, while the latter aptitude was probably due in part to their Negro ancestry. This duality of occupation led to variability in mode of life. In some places the land invited the population towards husbandry, in others the physical conditions were more suited to a pastoral life, and thus we find the settled Baronga on the one hand and the wandering Ovaherero on the other. The Bantu peoples easily adopt changes of custom; under the leadership of a warlike chief they become warlike and cruel, a common characteristic of pastoral peoples, while it is recorded that many of the Matabele, taken prisoners by the Barotse, settled down peacefully to agriculture. The history of the prolific Bantu peoples on the whole indicates that they were as loosely attached to the soil as were the Ancient Germans, and like the latter, at the slightest provocation, they would abandon their country and seek another home. This readiness to migrate is the direct effect of a pastoral life, and along with this legacy of unrest their Hamitic ancestors transmitted a social organisation which lent itself to discipline. These were the materials, so to speak, ready to hand when organisers should appear. Nor have such been lacking, for such names as Dingiswayo, Chaka, Dingan, Moselekatze, Lobengula, Moshesh, Sebituane, Cetewayo, and others are writ large in the annals of South Africa; and the statesman Khama is an example of what civilisation can do to direct this executive ability into proper channels.

Archaeology.

The archæology of South Africa is now attracting considerable local interest, and we may confidently expect that new discoveries will soon enable us to gain some insight into the dense obscurity of the past. It cannot be too strongly insisted upon that the methods of the archæologist should be primarily those of the geologist. Accurate mapping of deposits or localisation of finds is absolutely necessary. The workmanship of an implement is of little evidential value: the material of which it is made may be refractory, the skill of the maker may be imperfect, or he may be satisfied with producing an implement just sufficient for his immediate need; and there is always a chance that any implement may be simply a reject. The early generalisation of implements in England into two groups, Palæolithic and Neolithic, expressed a fact of prime importance, but now the classification has extended. It is obvious that the shapely palæoliths of the older gravels could not have been the first attempts at implement-making by our forefathers, and the presumed hiatus between the two epochs has been bridged over by evidence from sites on the European mainland. Our knowledge is increasing apace and an orderly sequence is emerging, but there are many interesting variations, and even apparent setbacks, in the evolution of industrial or artistic skill. In a word, sequence and technique must not be confounded, and our first business should be to establish the former on a firm basis; but, as I have just remarked, this can be accomplished only by adhering rigidly to the stratigraphical methods of the geologist. It would probably be to the interest of South African archæology if the terms "Eolithic," "Palæolithic," and "Neolithic" were dropped, at all events for the present, and it might prove advantageous if provisional terms were employed, which could later on be either ratified or abandoned, as the consensus of local archæological opinion should decide.

In certain lands of the Old World, north of the Equator, there was a progressive evolution from the Stone Ages, through a copper and a bronze age, to that of iron; but the stone-workers of South Africa appear to have been introduced to iron-smelting without having passed through the earlier metal phases, since the occurrence of copper implements is too limited to warrant the belief that it represents a definite phase of culture. The similarity of the processes employed in working iron by the different tribes of Africa, south of the equator, indicates that the culture was introduced from without, a conclusion which is supported by the universal use of the double bellows—a similar instrument is in use in India and in the East Indian Archipelago. Some ethnologists hold that Africa

owes to India its iron industry and other elements of culture, as well as the introduction of the ox, pig, and fowl. At all events, we shall probably not be far wrong if we assign a fair degree of antiquity to the knowledge of iron in tropical and southern Africa.

The characteristic metal of South Africa is gold, and its abundance has had a profound effect on the country, although, strange to say, it was not employed by any of the native races on their own initiative. We cannot tell when it was first discovered or by whom, but the hundreds of ruins scattered over a large extent of country, and the very extensive ancient workings, testify to the importance and the long continuance of this industry; for there can be no doubt that the builders of these wonderful remains came to this country mainly for the sake of its goldfields, though there must also have been an important trade in ivory, and incidentally in other local produce. Positive demonstration is as yet lacking concerning the nationality of the first gold-workers. This much is certain: they must have come to South Africa originally for some other product, since the aborigines did not work the metal, and it is most probable their quest was for ivory, and it was these hunters and traders who discovered the surface gold. Further, the discoverers must have come from a country where quarrying and metal-smelting were practised, and this implies the organisation of labour, for in early times, as history abundantly proves, mining was always undertaken by means of forced labour. The gold-workers, who probably came from Southern Arabia, belonged to a much higher social order than any of the peoples with whom they came in contact, and with their discipline in war and their industrial training they were able to subdue the Bantu inhabitants over immense tracts between the Zambesi and the Limpopo, to reduce them to slavery, to organise the working of the gold mines, and to establish a chain of forts and a system of communication with the coast. This occupation of the country by foreigners was purely for purposes of exploitation, and when, for reasons at present unknown to us, their hold weakened on the land, the whole enterprise fell to pieces, and the foreigners departed, they left indelible marks of their former presence on the face of the country, but in native industries and customs there is virtually no trace remaining of the rule of the more civilised Semitic overlord. The natives seem, as it were, to have awakened from a nightmare and straightway to have forgotten the hideous dream. Possibly this history may have been repeated more than once.

It is greatly to be deplored that in the past irresponsible prospectors have been permitted to rifle the ancient ruins for gold, with the result that not only have very numerous specimens of archæological interest been cast into the melting-pot, but at the same time collateral evidence has been destroyed, and thus valuable data lost to science. Even now the situation is not without its dangers, for the recently awakened interest in the ruins, and appreciation of their historical value, may lead to unconsidered zeal in excavation. After all, there is no especial hurry; what is perishable has long ago decayed, and so long as the ruins are sealed up by the rubbish that preserves them, no great harm can accrue, but in a few hours, by careless excavation, may be destroyed more archæological evidence than in centuries of neglect. Therefore it would be advisable for those in authority to consider carefully whether it is wise to lay bare new sites, unless proper examination and preservation can be ensured. The number of the ruins in Rhodesia is so great, and the area within which they occur so enormous, that it would be a very large undertaking for the Government systematically to investigate and permanently to conserve them all. Perhaps it would be possible to entrust some of this work to properly constituted local authorities, assisting them by grants and special facilities, but care would have to be taken to ensure the thorough carrying out of the work. Records of work done should be published, and the specimens preserved in authorised museums only. It is desirable also that every ruin should be scheduled under an Ancient Monuments Protection Act, and that an Inspector or Curator of Ancient Monuments should be appointed, who would be responsible for the excavation and preservation of all the monuments. To a less extent these remarks apply also to other parts of South Africa. All relics of the past, such, for example, as the pictographs in the rock-shelters of the Bushmen, should be jealously preserved and guarded from intentional or unwitting injury.

I trust my South African colleagues will forgive me if I have appeared too much in the character of a mentor. I have endeavoured to present a general view of the anthropological situation in South Africa, without burdening my remarks with details, and at the same time I have made bold to publish some of the conclusions which this survey has suggested; but there are other points on which I feel constrained to touch.

Recently Sir Richard Temple delivered an Address on "The Practical Value of Anthropology," in the course of which he said: "We often talk in Greater Britain of a 'good' magistrate or a 'sympathetic' judge, meaning thereby that these officials determine the matters before them with insight; that is, with a working anthropological knowledge of those with whom they have to deal. . . . It is, indeed, everything to him to acquire the habit of useful anthropological study before he commences, and to be able to avail himself practically and intelligently of the facts gleaned, and the inferences drawn therefrom, by those who have gone before him. . . . Take the universally delicate questions of revenue and taxation, and consider how very much the successful administration of either depends on a minute acquaintance with the means, habits, customs, manners, institutions, traditions, prejudices, and character of the population. In the making of laws too close a knowledge of the persons to be subjected to them cannot be possessed, and, however wise the laws so made may be, their object can be only too easily frustrated if the rules they authorise are not themselves framed with an equally great knowledge, and they in their turn can be made to be of no avail unless an intimate acquaintance with the population is brought to bear on their administration. For the administrator an extensive knowledge of those in his charge is an attainment, not only essential to his own success, but beneficial in the highest degree to the country he dwells in, provided it is used with discernment. And discernment is best acquired by the 'anthropological habit.' . . . . The habit of intelligently examining the peoples among whom his business is cast cannot be overrated by the merchant wishing continuously to widen it to profit; but the man who has been obliged to acquire this kind of knowledge without any previous training in observation is heavily handicapped in comparison with him who has acquired the habit of right observation, and, what is of much more importance, has been put in the way of rightly interpreting his observations in his youth."

In referring to civil-servants, missionaries, merchants, or soldiers, Sir Richard Temple went on to say: "Sympathy is one of the chief factors in successful dealings of any kind with human beings, and sympathy can only come with knowledge. And not only does sympathy come of knowledge, but it is knowledge that begets sympathy. In a long experience of alien races, and of those who have had to govern and deal with them, all whom I have known to dislike the aliens about them, or to be unsympathetic, have been those that have been ignorant of them; and I have never yet come across a man who really knew an alien race that had not, unless actuated by race-jealousy, a strong bond of sympathy with them. Familiarity breeds contempt, but it is knowledge that breeds respect, and it is all the same whether the race be black, white, yellow, or red, or whether it be cultured or ignorant, civilised or semi-civilised, or downright savage."

I have quoted at length from Sir Richard Temple, as the words of an administrator of his success and experience must carry far greater weight than anything I could say. I can, however, add my personal testimony to the truth of these remarks, as I have seen Britons administering native races on these lines in British New Guinea and in Sarawak, and I doubt not that I shall now have the opportunity of a similar experience in South Africa.

In this connection I ought to refer to what has been already done in South Africa by the Government. In the year 1880 the Government of Cape Colony, confronted by

the problem of dealing with the natives, appointed a Commission to inquire into the native laws and customs which obtained in the territories annexed to the Colony, especially those relating to marriage and land-tenure, and to suggest legislation, as well as to report on the advisability of introducing some system of local self-government in the native territories annexed to the Colony. The example was shortly afterwards followed by the Government of Natal, which had native problems of its own. These two Commissions collected and published a considerable amount of evidence, valuable not only for the immediate purpose in view, but also for the purposes of science. Before the late war came to a close the Anthropological Institute of Great Britain and Ireland and the Folklore Society addressed to Mr. Chamberlain, then Colonial Secretary, a memorial praying that on the conclusion of peace a similar Commission should be issued to inquire into the customs and institutions of the native tribes in the Transvaal and the Orange River Colony, and, with a view to the accomplishment of more directly scientific ends, praying that at least one anthropologist of eminence unconnected with South Africa should be included in the Commission. The prayer of the memorialists was bluntly refused. When, however, in the course of reorganisation of the administration, a conference was held at Bloemfontein in 1902 of the Ministers of the various colonies, protectorates, and territories, to discuss native affairs, they found themselves, in the words of Sir Godfrey Lagden, "much confused because the laws and the conditions of all the colonies were different." This was exactly what the memorialists had told Mr. Chamberlain. So the conference determined on the appointment of a Commission of Inquiry, which was issued in due course by Lord Milner in September, 1903, and reported on January 30 last. The evidence taken by this Commission, as well as that taken by the previous Commissions, is of a very valuable character. But, like those Commissions, its object was exclusively administrative. Consequently the evidence is only incidentally of ethnological interest, and it by no means covers the whole ground. The social life and marriage laws are to a great extent laid before the reader, but there is no attempt to distinguish accurately between one tribe and another; the native institutions are discussed only so far as they have a practical bearing on administrative questions. There is no attempt to penetrate to the underlying ideas and beliefs, and the vast domain of religion lies for the most part outside the ken of the Commissioners. Admirable, therefore, as is the work done by these Commissions, it is but a small part of what must be undertaken if an accurate account of the natives of South Africa is to be obtained and preserved for scientific use, and as an historical record. What is wanted is that the Government should undertake this enterprise in the same way as the Governments of the United States, Germany, the Netherlands, and other countries investigate their native races, or, failing this obvious duty of a Government, that adequate assistance should be given to societies or individuals who may be prepared to take the matter in hand.

Unfortunately it is not unnecessary to insist on the need there is for us to consider seriously what at any particular time is most worth investigating, and not to let ourselves drift into any casual piece of work. Let us apply that simple test to South Africa, and ask ourselves, What most needs doing in anthropological research in South Africa?

So long as actual wanton destruction is not taking place, local archæological investigation can wait. I do not mean to suggest that those who have the opportunity should not devote themselves to this important subject; many can do good work in archæology who have neither opportunity nor inclination for other branches of anthropology, and the British South Africa Company has shown and probably will continue to show a real interest in this work. But our first and immediate duty is to save for science the data that are vanishing; this should be the watchword of the present day.

Observations in South African anthropography are lamentably deficient. Although scattered up and down in books of travel and in missionary records there are descriptions of individuals, and in some cases a few salient features of a tribe are noted, yet we have few precise descriptions of communities that are of value for comparative purposes. Anthropometrical data are everywhere wanting; very few natives have been measured, and the measurements that have been made are insufficient both as regards those actually taken and the number of individuals measured. The interesting subject of comparative physiology is unworked. We have no observations in experimental psychology, and very few trustworthy data in observational psychology. Here, then, is a large field of inquiry.

I am not competent to speak concerning linguistics, but from what I have read I gather that a very great deal yet remains to be done, at all events in phonetics, grammar, and comparative philology.

In general ethnology a considerable amount of scattered work has been done, but no one tribe has been investigated with scientific thoroughness; the best piece of work hitherto accomplished in this direction is the admirable memoir on the Baronga by the missionary H. A. Junod, which leaves little to be desired. It would be well worth while for students to make exhaustive studies of limited groups of people, tracing all the ramifications of their genealogies in the comprehensive method adopted by Dr. Rivers for the Torres Straits Islanders and for the Todas; this method is indispensable if it is desired to obtain a true conception of the social structure of a people, their social and religious duties, the kinship relationships, and other information of statistical and sociological value. Other fruitful lines of inquiry are the significance of the form and ornamentation of objects and the symbolism (if there is any) of the decorative art, a subject which, as far as I am aware, is absolutely untouched. Even the toys and games are worth investigation. Hardest but most important of all, there is that intricate complexus of action and belief which is comprised under the term "religion." This needs the most delicate and sympathetic treatment, although too often it has been ruthlessly examined by those who were more prone to seek the ape and the tiger and vain imaginings in the so-called "superstitious" practices of these poor folk. They are laggards along the road which our more favoured ancestors have trod, but they all have their faces set in the same direction as our own, towards that goal to which we ourselves are striving. To induce natives to unbosom themselves of all that they hold secret and sacred and to confess their ideals and inspirations requires more than an ordinary endowment of patience, tact, and brotherly kindness; without these qualities very little can be gathered, and the finer side of native thought and feeling will for ever remain a sealed book to the European. In referring to this subject it should not be overlooked that the best account we have of the religion of the Zulu-Xosa peoples is due to the labours of Bishop Callaway. The number of native texts, including folk-tales, published by him are especially valuable, as they throw light from all sides upon the native mind, and it is greatly to be regretted that he lacked the pecuniary and other encouragement that was necessary for the completion of his labours. The most urgent of all the foregoing lines of inquiry are the most elusive; these are the ideas, beliefs, and institutions of the people, which are far less stable than are their physical characteristics.

These are some of the lines of research that await the investigator. The field is large, but the opportunities are fleeting. The Kattea, Bushmen, and Hottentots are doomed, and new social conditions are modifying the Bantu peoples. Here again we must apply the test question, Which of these peoples most needs investigation? The answer again is obvious. Those that will disappear first. All over South Africa this work is pressing. For some tribes it is too late. It would be a memorable result of the meeting of the British Association in South Africa if it should lead to an exhaustive study of those most interesting people, the Kattea, the Bushmen, and the Hottentots. They represent very primitive varieties of mankind, but their numbers are rapidly diminishing, and, as races, they have no chance of perpetuity. What judgment will posterity pass upon us if, while we have the opportunity, we do not do our best to save the memory of these primitive folk from oblivion?

A Short Bibliography of Books on the Ethnology of South Africa.

Ankermann, B. .	Kulturkreise und Kulturschichten in Afrika. *Zeitschrift für Ethnologie*, vol. xxxviii. Berlin, 1905.
Arbousset, T., and Daumas, F.	Narrative of an Exploratory Tour to the North-east of the Colony of the Cape of Good Hope. (Translated by J. C. Brown.) Cape Town, 1846; London, 1852.
Barthel, K. . . .	Völkerbewegungen auf der Südhälfte des Afrikanischen Kontinents. "Mitt. Vereins für Erdkunde zu Leipzig" (1893), 1894.
Bleek, W. H. I. .	Reynard the Fox in South Africa; or, Hottentot Fables and Tales. London, 1864.
,,	Report concerning Bushman Researches. Printed by order of the House of Assembly. Cape Town, 1873.
,,	Second Report. A brief account of Bushman Folklore and other Texts. Cape Town, 1875.
Callaway, H. . .	Nursery Tales, Traditions, and Histories of the Zulus. London, 1868.
,,	The Religious System of the Amazulu. London, 1870.
Casalis, F. . . .	The Basutos. London, 1861.
Fritsch, G. . . .	Die Eingeborenen Süd-Afrika's (with Atlas). Breslau, 1872.
Hahn, T. . . .	Tsuni-Goam, the Supreme Being of the Khoi-Khoi. London, 1881.
Johnston, H. . .	British Central Africa. London, 1897.
,,	The Uganda Protectorate. London, 1902.
Junod, H. A. . .	Les Chants et les Contes des Ba-Ronga. Lausanne, 1897.
,,	Les Ba Ronga. Neuchatel, 1898.
Keane, A. H. . .	Man: Past and Present. Cambridge, 1899.
,,	The Boer States. London, 1900.
Kidd, D.	The Essential Kafir (with an interesting but incomplete Bibliography). London, 1904.
Kolben, P. . . .	The Present State of the Cape of Good Hope. London, 1731.
Leslie, D. . . .	Among the Zulus and Amatongas. Second edition. Edinburgh and London, 1875.
Livingstone, D. .	Missionary Travels and Researches in South Africa. London, 1857.
Lloyd, L. C. . .	A Short Account of Bushman Material. Third Report presented to both Houses of Parliament; Cape Town. London, 1899.
Maclean, J. . . .	A Compendium of Kafir Laws and Customs. Cape Town, 1866.
Moffatt, R. . . .	Missionary Labours and Scenes in Southern Africa. London, 1842.
Préville, A. de . .	Le Continent Africain. "La Science Sociale," tomes v., vi. Paris, 1888.
Stow, G. W. . .	The Native Races of South Africa. London, 1905.
Theal, G. M. . .	Kaffir Folk-Lore. London, 1882.
,,	The History of South Africa. (5 vols.) London, 1888-1900.
,,	The Beginning of South African History. London, 1902.
Wood, J. G. . .	The Natural History of Man. London, 1868.
Wangermann . .	Ein Reise-Jahr in Süd-Afrika. Berlin, 1868.

Basutoland Records. In three vols., 1833-1852; 1853-1861; 1862-1868.
Folk-lore Journal. Vol. i. 1879; Vol. ii. 1880. Cape Town.
Report and Proceedings, with Appendices, of the Government Commission on Native Laws and Customs (1881-82). Cape Town, 1883.
The Natives of South Africa: their Economic and Social Condition. Edited by the South African Native Races Committee. London, 1901.
Report and Proceedings of the South African Intercolonial Commission on Native Affairs, 1903-05. Cape Town, 1905. (Report, 1 vol. Minutes of Evidence, 5 vols.)

The foregoing list of books is manifestly very incomplete. A considerable amount of information concerning the natives will be found in numerous books by missionaries, travellers, and sportsmen.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. E. G. BAWDEN has entrusted Mr. Edgar Speyer "with a sum in cash and securities of about 100,000*l.* to be applied to purposes of charity and benevolence, and for the advancement of knowledge, especially in aid of human suffering." After careful consideration, this sum has been apportioned for various good purposes in the form of capital to be vested in trustees, and to be known in each case as the "Bawden Fund." The largest allotment is in aid of advanced university education and research, and for this purpose a gift of 16,000*l.* is made to complete the sum of 200,000*l.* required to bring about the incorporation of University College in the University of London.

THOUGH the corporation of the Massachusetts Institute of Technology has taken action in connection with the proposed alliance of the Institute with Harvard University, the faculty and alumni have expressed their disapproval of the scheme. Before the proposed agreement can be consummated there will be necessary at least three decisions by the Supreme Judicial Court upon the grave legal questions involved, action by the Harvard authorities, and possibly further consideration by the corporation of the institute and an appeal for legislative sanction. A league has therefore been organised "to oppose the plan of alliance under consideration, or any other plan which may impair the self-government of the institute, and to secure for the past students a proper share in its administration."

PROF. W. HALLOCK, professor of physics in Columbia University, New York City, writes to say that the proposal of the Emperor of Germany for the temporary interchange of professors with America, referred to in NATURE of July 20 (p. 285), had nothing to do with the courses arranged at that university, as they were planned three years ago, when Prof. Hallock took charge of the department of physics. The lecturers are not exchanged; they are appointed as "non-resident lecturers" for the year, and receive an honorarium for their courses. The visiting lecturers at Columbia University for the year 1906-7 are Prof. Lummer, of Breslau, and Dr. J. Larmor, F.R.S.

A COPY of the prospectus of the Redruth School of Mines for 1905-6 has been received. Situated in the centre of the Cornish mining district, the school is devoted wholly to instruction in mining and allied subjects essential to the training of mining engineers, assayers, and mine-surveyors. Practical work in mining is carried on at the

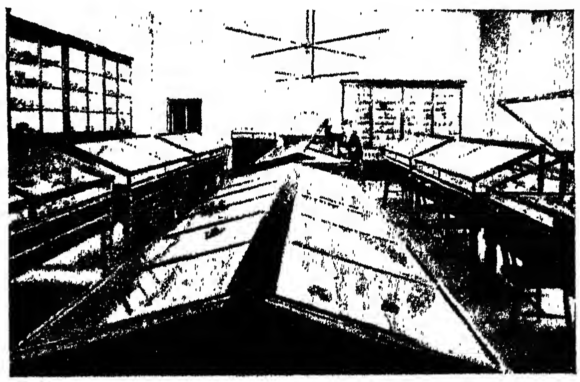

FIG. 1.—The Hunt Museum, Redruth School of Mines.

Basset mines and at other mines in the vicinity under the supervision of the school instructor. Success in examinations in particular subjects held at the school by the Board of Education, the City and Guilds of London Institute, and the County Council of Cornwall forms part of the requirements for a school certificate. One wing of the school building is occupied by a large mineral gallery erected in memory of the late Mr. Robert Hunt, F.R.S., keeper of the mining records. This museum, which contains a very valuable collection, offers great facilities for mineralogical study.

CORRESPONDENCE between the Bengal Government, the Government of India, and the Secretary of State for India upon the subject of the establishment of a school of mines in India, extending over the period from May 21, 1904, to August 3, 1905, has been published. On the advice of a strong committee, the proposal adopted is to provide a curriculum of mining instruction at the Sibpur Engineering College, Calcutta, with practical instruction in the mining districts. A professor of mining engineering is to be appointed in England at a salary of 750 rupees to 1000 rupees a month. The scheme also contemplates the temporary appointment for five years of a peripatetic mining instructor and a native assistant, who will be called upon to give free instruction in the mining districts. The whole scheme involves an initial expenditure of 8500 rupees on the equipment of Sibpur College, and an annual recurring expenditure of 16,000 rupees in connection with that college, and of 15,000 rupees for peripatetic instruction in the mining districts. For a scheme so promising in economic benefit to India, the outlay appears extremely moderate.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 8.—"The Elastic Properties of Steel at High Temperatures." By Prof. B. **Hopkinson** and F. **Rogers**. Communicated by Prof. Ewing, F.R.S.

In the experiments described in this paper, the elastic properties of steel and iron have been investigated at higher temperatures, ranging up to 800° C., and for stresses greatly below that required to rupture the material. The authors have found that as the temperature rises the stress-strain relations undergo a remarkable change, which may best be expressed by saying that what is variously called the "time-effect," or "elastische nachwirkung," or "creeping," increases greatly with the temperature. Steel, at high temperatures, behaves like indiarubber or glass; if it is stressed for a time, and the stress removed, it does not at once recover, but after the immediate elastic recovery there is a slow contraction perceptible for many minutes. Such "creeping" can be detected at the ordinary temperature, but at a red heat it attains a different order of magnitude, becoming (in its total amount) a substantial fraction of the whole deformation.

This phenomenon is analogous to residual charge in glass and other dielectrics; the stress corresponding to the electric force, and the strain to the electric displacement. Whether the law of linear superposition of the effects of stresses—closely followed in the electrical analogy—is true for hot steel or iron, is an interesting question which the apparatus used was hardly sufficiently delicate to answer.

The magnitude of this effect in steel may best be gauged by comparing it with other cases of the same kind, *e.g.* with the slow recovery of a glass fibre after twisting; if such a fibre be twisted through a considerable angle for several hours, it will recover all but one-fiftieth of the twist within two or three seconds of the removal of the stress. The remaining slow "creep," amounting to one-fiftieth of the whole deformation, corresponds to the slow return of the steel. In indiarubber, in certain circumstances, 10 per cent. of the strain disappears in time after the removal of the stress. But in steel, at 600° C., the proportion is about 15 per cent.

Another effect of "creeping," such as the authors have observed, is to make the determination of Young's modulus a matter of some uncertainty. Thus the extension of the bar at 600° C. produced by a given load varies 15 per cent. or more, according to the time of application of the load. When, however, the load is applied for a very short time, say of the order of one or two seconds, the strain produced seems to approach to a definite limiting value which is the instantaneous extension or contraction of the bar observed in the experiments when the load is applied or removed. It seems reasonable to define Young's modulus for a metal in this state, as the stress divided by this limiting instantaneous strain. It is then independent of the manner of loading, and is a definite physical constant; otherwise not.

"On the Refractive Index of Gaseous Fluorine." By C. **Cuthbertson** and E. B. R. **Prideaux**. Communicated by Sir William Ramsay, K.C.B., F.R.S.

The authors have determined the refractive index of gaseous fluorine for sodium light by means of Jamin's refractometer. Five experiments gave values for the refractivity $(\mu-1)$ 10^6 of 195, 177, 192, 194, and $198\frac{1}{2}$. The discrepancy exhibited by the second experiment can be accounted for, and it is believed that the mean of the other four experiments, 195, is within 2 or 3 per cent. of the true value.

In a recent paper (*Phil. Trans.*, A, vol. cciv. p. 323), one of the authors has attempted to show that the refractivities of the different members of the same chemical group are related in the ratios of small integers; and it was observed that, if this coincidence were not due to chance, the refractivity of fluorine should bear to that of chlorine the ratio of 1 to 4, which those of neon, oxygen, and nitrogen bear to argon, sulphur, and phosphorus respectively. This prediction has been verified. The refractivity of chlorine for sodium light is 768, or 192×4; and that now found for fluorine is 195, a discrepancy of $1\frac{1}{2}$ per cent., which is well within the limits of error of the experiment.

Paris.

Academy of Sciences, August 28.—M. Troost in the chair.—The ultra-violet spectra of the reversing layer during the total eclipse of May 28, 1900: H. **Deslandres**. An account of the apparatus employed, and a short list of the principal lines of titanium, vanadium, and chromium observed.—On a differential equation of the fourth order: Gaston **Darboux**.—On transcendental numbers: Ed. **Maillet**.—Researches on irradiation: Adrien **Guébhard**.—On a method suitable for the study of a luminous phenomenon varying in intensity with the time. Application to the determination of the instantaneous velocity of a rotating mirror and to the study of the Hertzian spark: A. **Turpain**. The arrangement is a modification of the Foucault experiment for the determination of the velocity of light. The receiving eye-piece is replaced by a photographic plate, and the spark is placed between the rotating and fixed mirrors. The measurement of the distance on the negative between the two images, the one caused by the light travelling directly and the other by reflection from the fixed mirror, and of the distances apart of the portions of the apparatus, gives an accurate determination of the velocity of the mirror, the velocity of light being taken as known. The method has been also applied to the study of the spark given by a Hertzian excitor and resonator, but the description of this part of the work is reserved for a later communication.—A new group of protophytic parasites, Ecrinides: L. **Léger** and O. **Duboscq**.—A contribution to the cytological study of the Cyanophyceæ: A. **Guilliermond**.—*Sterigmatocystis nigra* and oxalic acid: P. G. **Charpentier**. This mould, when cultivated in Raulin's fluid, never secretes oxalic acid before spore formation takes place, but sporulation acts only indirectly in causing the secretion, this being caused by the exhaustion of the medium.

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THURSDAY, SEPTEMBER 14, 1905.

ASTRONOMY FOR TRAVELLERS.

Handbuch der geographischen Ortbestimmung für Geographen und Forschungsreisende. By Dr. Adolf Marcuse. Pp. x+342+2 charts; illustrated. (Brunswick: Friedrich Vieweg und Sohn, 1905.)

A SHORT preface by the author tells us that this book is designed, in the first place, to give assistance to geographers and explorers, to aid students of the mathematical sciences and pupils in the higher schools, and to serve as an introduction to those parts of astronomy which, since they are concerned with the determination of time and of position on the earth's surface, have an important influence on everyday life. One does not expect, therefore, a description or an explanation of the nicest details that lead to the greatest accuracy, but rather the exhibition of the general principles on which the determination of coordinates depends; and on the whole this ground is fairly well covered, both from a theoretical and practical point of view. But when an author poses as a teacher, we are apt to examine his book a little closely, to see if he has shown any sign of clearly apprehending the difficulties that learners and pupils encounter when attacking a new subject, and made any adequate effort to remove these difficulties. There is no evidence of any particular care in this direction, though, of course, it is no easy matter to detect beforehand where the pitfalls and misconceptions on the part of the pupil will arise, and points that seem to one teacher to demand a lengthened explanation or further illustration do not present themselves in the same way to the judgment of another expert.

But there is another test which may be more safely applied. Are any matters introduced which give needless complexity, or delay the continuous progress of the work? In this respect we think the author is not altogether blameless. For instance, the section on "probable error" and the solution of equations by the method of least squares seems on this ground out of place. The subject in the space given to it is not, and cannot be, treated exhaustively; it must leave but a very hazy notion in the student's mind, and the application of the theory is not wanted in the discussion of the rough results which are derived from the instruments that are employed. Similarly, what has a traveller dealing with approximate values of latitude and longitude to do with the small variations arising from the motion of the Pole? It seems a little inconsistent to suggest a degree of accuracy in the final results which cannot be realised with the particular means adopted.

If these are details into which it would have been better not to have entered, there are, on the other hand, omissions, or at least what appear to be omissions, to which some reference should have been made. Thus, by way of illustration, we may mention the absence of all reference to the sextant and artificial horizon in the portion of the book devoted to the description of instruments. The author is perhaps desirous that his book should not be confounded with the many treatises on nautical astronomy and the methods of reduction therein employed; but the sextant has as distinct a value in exploring new country as the chronometer, to which the author devotes a very satisfactory section. In the determination of longitude, the sextant applied to the measurement of lunar distances affords more trustworthy results than does the observation of Jupiter's satellites, on which the author would apparently rely. Occultations of stars by the moon, which is merely a particular case of the method of lunar distances, are referred to at considerable length. A numerical example of the application of the method is worked out in full, and in all the various methods of deriving the latitude and longitude detailed examples are furnished. This is a very satisfactory feature of the book, and we could have wished that the selection of examples had been more varied and had included the method of lunar distances.

If these omissions seem to us to be slight blemishes on an otherwise excellent book, it is with the greater pleasure that one can turn to the consideration of the sections which treat of matters of more novelty and originality. In the chapter devoted to instruments we meet with a "level-quadrant" (Libellenquadrant) with which we are unfamiliar, and though it appears to be distinctly inferior to the sextant, it may be of advantage in some situations. The peculiar feature of the instrument consists in the fact that the bubble of a level carried on a rotating arm is reflected into the field of view and made to do the same service as the reflection of the sun to the horizon by means of the ordinary arrangements found in the sextant. In the case of determining the position of a balloon when the earth may be invisible owing to clouds passing beneath the observer, such an arrangement can be used with effect. In the chapter on the determination of a balloon's course, the method is applied with very considerable success. The path of a balloon from Berlin to a point beyond Breslau, a complete run of about 400 kilometres, is worked out, and the average error appears to be about 16 kilometres. This would be a large error on board ship, but the conditions are not the same, nor is there the same necessity for accuracy. The aëronaut has simply to take care that he does not run out to sea; the navigating officer has to make a land fall. The calculations in this section have been materially shortened by the use of the so-called Mercator function, which, in the examples given, does away with the necessity of logarithmic tables, and suggests a method of working that seems to be well worth the little study that is necessary to master the application of it.

Lastly, we may mention an ingenious method of determining approximately geographical positions without the use of graduated instruments. Threads supporting a weight at the apex of a triangle so as to ensure verticality and to give steadiness can be hung on tent poles, and over these threads the transit of stars can be observed with the naked eye. Then, knowing the time, the latitude, longitude, and azimuth can be approximately derived; and when

instruments have been injured or delayed, or are generally inaccessible, such methods are not to be despised. It would be an admirable exercise for anyone, whether he travels or not, to accustom himself to the use of such tools, and learn to what degree of accuracy he can rely on such devices.

THE EVOLUTION OF HUMAN SOCIETY.

La Sociologie génétique. By François Cosentini. Introduction by Maxime Kovalewsky. Pp. xviii +205. (Paris: F. Alcan, 1905.) Price 3.75 francs.

IN a short compass this book gives an excellent bird's-eye view of a very wide territory. It begins with a discussion of the data available for the study of the evolution of human society. Even animal associations are not neglected, but, naturally, more space is devoted to the beliefs and customs of savage tribes. Our author decides wisely with regard to primitive man that much is to be learnt thus. But he deprecates rash inferences. The ancestors of civilised man, there is reason to believe, never ceased to make progress. The savages of the present day have stagnated, and may, in some cases, have retrograded. Still, when the theories that suggest themselves to the investigator of savages and their ways are modified and corrected by the study of the institutions, the beliefs, the folk-lore of civilised peoples, it is probable that the risk of serious error is reduced to very small proportions.

M. Cosentini decides in favour of a polyphyletic origin of the human race, arguing partly from the reduced fertility observable when two widely different types interbreed. After a brief but interesting account of the Palæolithic and Neolithic ages, he deals with the origin of the family. Here, as elsewhere, he shows sound judgment in his treatment of the various rival theories. He refuses to regard the patriarchal family as primitive. The more primitive the community the less sign is there of patriarchal authority. On the other hand, it would be foolish to maintain that there was ever a time in which woman was absolutely predominant. This view is precluded by the fact that primitive man had to wage incessant war against wild beasts and almost incessant war against hostile tribes. But there is abundant evidence that there was a time when a man was known as his mother's son and not as his father's, when pedigrees were traced through the female line, and when women had much more power and influence than at a later period when the patriarchal system had been developed. When the tendency changed and the paterfamilias became an autocrat within his own household, civilisation made great progress.

The family has been the nucleus which has made the higher civilisation possible, a point which, perhaps, M. Cosentini does not sufficiently recognise. Our author is, no doubt, right in holding that the idea of the family grew out of the idea of private property. The wife was the property of her husband. In very many cases he had captured her as he had captured his cattle. But with regard to monogamy, M. Cosentini does not bring out the interesting fact that in northern climes, where it is most firmly rooted, it derives its strength mainly from the fact that one man's labour suffices for the feeding and clothing of only a small number of children. Even among animals we find the same thing. Where the work of both parents is required for the bringing up of the young, there the system of pairing is the rule. Where the young are precocious and are soon able to fend for themselves, polygamy arises.

On the remainder of the book want of space forbids us to comment at length. It deals with animism, myths, language, religion, morality, law, the origin of social classes, art, industry, and commerce. The style is clear; and throughout the book M. Cosentini proves himself a fair critic and a clear-headed thinker.

F. W. H.

OUR BOOK SHELF.

Trees. By H. Marshall Ward. Vol. iii. Flowers and Inflorescences. Pp. xii+402. (Cambridge: The University Press, 1905.) Price 4*s.* 6*d.* net.

THE first two volumes of the above work have been previously noticed in these columns. The present volume, which deals with flowers, is, like the others, divided into two parts. Part i. deals with the flower in general. The author has been very successful in his treatment of this vast subject; he has brought together and arranged his facts in such a clear and simple manner that the beginner should have no difficulty in gaining a very comprehensive knowledge concerning the different kinds of inflorescences, the structure and development of flowers, as well as the meaning of their various forms and modifications. So far as possible technical terms have been carefully avoided, but at the same time it is quite impossible to treat a subject like this without using one or two terms which have a special meaning of their own which cannot be readily put into every-day language. Wherever such expressions are used their meaning is always carefully explained, and at the end of the book a useful glossary is given which will remove all mystery concerning these terms should any such exist.

The author has naturally confined himself to a critical examination of the flowers of trees and shrubs, and the student will find here an epitome of the natural system of classification, and when this epitome has been mastered he will be in a position to understand the structure and form of the flowers of cultivated and wild herbaceous plants as well.

Part ii. is more of the nature of a flora, *i.e.* the author has given in tabular form a general conspectus of woody plants and their flowers, by which means any given species may be easily diagnosed at flowering time.

It is a well known fact that the willows are almost, if not, the most difficult family to deal with as regards their identification. Apart from their tendency to hybridise with each other, the willows are diœcious, which renders their identification very difficult when only one kind of flower is available. The author has very ingeniously overcome this difficulty by giving a special table as an appendix wherein the separate characters of the male and female flowers are used for the purposes of diagnosis.

This volume, like the other two, is profusely illustrated. There is also a very useful and exhaustive index at the end of the book. While vol. i., "Buds and Twigs," is a book for the winter study of trees and shrubs, we have in vol. iii. a book which is specially adapted for use in summer.

A Laboratory Guide in Elementary Bacteriology. By Dr. William Dodge Frost. Third revised edition. Pp. xiii+395. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 7*s.* net.

THIS book is, as stated in the title, a guide for practical laboratory work in elementary bacteriology. The student is taken step by step through the various processes of cleaning and setting up apparatus, sterilisation, preparation of culture media, demonstration of gas production, and detection of certain chemical products, the result of microbial activity. The isolation and cultivation of bacteria, and staining methods, are then considered, and a few exercises are given on the physiological properties of micro-organisms, such, for example, as the influence of the reaction of the medium on growth, the effects of desiccation, &c. The student is next introduced to the systematic study of types, first of non-pathogenic and then of the chief pathogenic forms. In this, as well as in the preceding portions of the book, a heading only is given, and to the exercises and practical work, and pages are left blank for the student's own notes, subheadings indicating what he should observe and look for, the facts observed being entered up by the student himself. In addition, outline diagrams are given of culture tubes which are to be filled in with the students' own drawings. In this way the guide becomes a permanent note-book and record of the student's work. Finally, directions are given for the inoculation and *post-mortem* examination of animals, and a key index of the characters of the more important species concludes the volume. At the end of each section a reference is given to the principal manuals and text-books of bacteriology, such as Abbott's, Chester's, Eyre's, Hewlett's, Muir and Ritchie's, Sternberg's, &c., so that the student may read up the subject. So far as we have been able to observe, the directions given are clear and concise, the exercises judiciously chosen, and the book is singularly free from errors. That a third edition should have been called for is sufficient evidence of the need for such a book, and for those who desire and work from a laboratory guide, and to lighten the labour of full and complete note taking, it may be strongly recommended. R. T. HEWLETT.

Nature-study Lessons for Primary Grades. By L. B. McMurry. Pp. xi+191. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1905.) Price 2*s.* 6*d.* net.

DR. C. A. MCMURRY, who has written the introduction to this volume, is one of the chief recognised authorities in America on elementary scientific education, and, indeed, on elementary education in general, and since he has probably read the proofs and given a general approval to the text, the work may be regarded as being written by one having authority. The plan of the work is to take a series of animals and plants and to show how the lessons to be learnt from them may be taught to pupils of tender years, or rather how the pupils may be trained to find out the meaning of the lessons for themselves. Having gained the confidence and attracted the interest of the pupils, the first object of the teacher should be to endeavour to foster and develop their own powers of observation and of drawing simple conclusions from such observations; and for this purpose the method adopted in the volume seems admirably adapted. Although it is not expected that all teachers will select the same objects for their texts, or that they should all follow by any means the same method of instructing, there can be no doubt of the advantage of having a list of those objects which appear most suitable for the purpose, and also of the benefits which younger teachers may derive from a perusal of the manner in which a more experienced member of their body handles her subject.

While the book appears admirably adapted for its purpose so far as teaching in America is concerned, it seems to require a word of warning when put into the hands of British teachers, and we think it would have been well had a special note to this effect been inserted in the copies intended for sale in this country. For instance, the teaching suggested in the chapter headed "The Robin" will apply for the most part excellently well to the bird so designated in this country; but when the inexperienced teacher (who is unaware that the so-called American robin is not our own familiar red-breast) reads that robins lay blue eggs he, or she, will be apt to put the book aside with the remark that the author does not know her subject. Again, it would much have simplified matters had the English teacher been informed that the plants known in America as "Morning-Glory" include the one commonly called *Convolvulus major* in this country.

With these limitations (which refer only to its issue in this country), we have nothing but praise to bestow upon Dr. and Mrs. McMurry's efforts to establish elementary biological teaching upon a sensible and practical basis. R. L.

Einführung in die Vektoranalysis mit Anwendungen auf die mathematische Physik. By Dr. Richard Gans. Pp. ix+226. (Leipzig: Teubner, 1905.) Price 8 marks.

THIS well-written book gives the usual definitions of scalar and vector products, introduces the now familiar differential operators "div" and "rot" (or "curl"), and uses them skilfully in the simpler applications of the line, surface, and volume integrals, associated with the names of Green, Gauss, and Stokes. The necessity for vector analysis in electromagnetic work is becoming more generally recognised, and Dr. Gans deserves the thanks of all for his able presentation of the outlines of the method, which, nevertheless, is at its best a "Quaternionenstenographie," as C. Neumann felicitously nicknames it. One has only to compare the demonstrations here given, which are primarily Cartesian and are then transformed into the concise vector notation, with corresponding quaternion demonstrations, such as may be found in Joly's "Manual," to see plainly the analytical gulf which separates Hamilton's *calculus* from other vector analyses, which are essentially shorthand *notations*. The mathematical historian of the future will find much food for thought in the mental shortsightedness of many vector analysts who delight in the use of contraction symbols like *grad, rot, div,* but despise the Hamiltonian selective symbols V and S, which with the real ∇ give the whole theory in exquisite compactness and flexibility. On a folding sheet at the end Dr. Gans gives a table of eighteen transformation formulæ, which presumably must all be learned off by rote. There does not seem to be any resemblance among the formulæ (h), (o), (q), which give respectively the equivalents of $[\mathbf{A}[\mathbf{BC}]]$, rot rot $\mathbf{A}$, rot $[\mathbf{AB}]$. In the quaternion notation $V\mathbf{A}V\mathbf{BC}$, $V\nabla V\nabla\mathbf{A}$, $V\nabla V\mathbf{AB}$, they are seen to be of the same "form," and are, indeed, analytically amenable to the same treatment. This is but one illustration of the inferiority of the "Quaternionenstenographie" to the real quaternion analysis. Dr. Gans gives interesting applications in hydrodynamics and in Maxwell's electromagnetic theory, but is limited somewhat by the fact that in this introduction there is no account taken of the linear vector function or matrix.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Observations of the Total Solar Eclipse in Tripoli, Barbary.

OUR eclipse took place in the midst of the fierce heat of the *Gibleh*, or Sahara sirocco; but an hour or two before totality the wind very fortunately changed, and brought skies of the highest possible optical transparency. There was no wind, and the conditions, except for the intense heat, which we momentarily feared would snap our great cameras, were the most nearly perfect imaginable at a sea-level station.

Unfortunately, on account of leaving home at very short notice, we brought no spectroscopic outfit, and our efforts were directed solely toward coronal photography with automatic and semi-automatic coronagraphs, and to exposure of plates for the slightly suspected intra-Mercurial planet. Other branches of our work related to coronal sketches, both with and without occulting discs, and to shadow band observations, both optically and photographically.

By the kindness of His Majesty's Government, represented by Mr. Alfred Dickson, Vice-Consul, the American expedition from Amherst College was permitted to establish its instruments on the terrace of the consulate, in the midst of the white city—in precisely the same spot occupied for the similar eclipse of 1900.

Many citizens of Tripoli took immediate and constant interest in our operations, and contributed very greatly to our success by their liberality in granting that service which only the chief of an expedition remote from home can fully appreciate. I am glad to mention especially Mr. W. F. Riley, Mr. W. H. Venables, Maris de Nunes Vais, the excellent photographer of the expedition, and Etim Bey, a Turkish gentleman resident in Tripoli, whose unique collection of photographic and mechanical appliances was frequently and helpfully drawn upon.

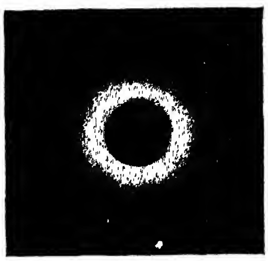

FIG. 1.—Total Solar Eclipse of August 30. Photographed at Tripoli.

The observations of shadow bands were conducted by parties organised by Mrs. Todd and Miss Todd, and will be reported to my friend Mr. Lawrence Rotch, of Blue Hill, at whose request they were made. These bands were seen as early as ten minutes before totality, and had many remarkable and pronounced peculiarities. They were wavering and narrow, moving swifter than one could walk, at right angles to the wind, their length with it, and waxing and waning five times during the eight minutes preceding totality.

The coronal sketches revealed nothing out of the ordinary. Extended rays beyond the occulting discs were looked for eagerly, but the disc (8 inches diameter at 35 feet distance) covered everything. The sky and general illumination were exceptionally bright. Totality as predicted was 3m. 9s. in duration; as observed 3m. 6s.

Our chief and largest instrument was a photographically corrected lens by Clacey, of 12 inches full aperture. To this was attached an orthochromatic screen for photographing Baily's beads, and a Burckhalter occulter as described by the writer four years ago in the *Monthly Notices*. Of the results obtained with this instrument I shall write elsewhere; about twenty exposures were made with it, and the beads are excellently shown in the accompanying photograph. The occulter was only in part successful.

Alongside it were the large Clark cameras, containing a pair of 3-inch lenses of 11 feet 4 inches focus, which took plates on which are a great number of stars, not yet fully examined. Owing to the unexpected brilliancy of the sky, the plates were exposed longer than would seem to have been wise. Everything to the eighth magnitude seems to have been caught, however.

A third instrument was a $3\frac{1}{2}$-inch Goerz doublet of about 18 inches focus, from which I removed the back lens, increasing the focal length to $33\frac{1}{2}$ inches. This was attached to one of the automatic movements used in my previous expeditions of 1896, 1900, and 1901. It was geared up to a rate of 265 photographs during the 189 seconds of totality, the exposure being about $\frac{1}{4}$ second for each. Most of these pictures are very good, and I enclose a print from one of them (Fig. 1), which does not, however, do the original negative justice. The corona was much less impressive, it strikes me, than other coronas I have seen—1878 and 1900 in clear skies, and 1887, 1889 (*b*), 1896, and 1901 in clouds; in fact, the shadow bands and Baily's beads seem to have been rather more interesting to the general observer than the corona itself.

DAVID TODD.

British Consulate, Tripoli, Barbary, August 31.

On the Class of Cubic Surfaces.

IN Salmon's "Geometry of Three Dimensions," the classes of the twenty-three different species of cubic surfaces are stated; but the process by which these results are obtained is not obvious. I therefore propose to indicate an easy method.

The class of a plane curve is equal to the number of tangents which can be drawn from a point not on the curve; hence the class of a curve is equal to the degree of its reciprocal polar. And since the line joining two points on a surface corresponds to the line of intersection of two tangent planes to the reciprocal surface, it is necessary, in order to make the theories of curves and surfaces correspond, to define the class m of a surface to be equal to the number of tangent planes which can be drawn through a given straight line. Let $(\alpha, \beta, \gamma, \delta)$ be quadriplanar coordinates referred to a tetrahedron of reference ABCD; then the equation of the tangent plane at any point (f, g, h, k) is

$$\alpha\frac{dF}{df} + \beta\frac{dF}{dg} + \gamma\frac{dF}{dh} + \delta\frac{dF}{dk} = 0 \qquad (1)$$

and if this plane passes through the line CD, we must have $dF/dh=0$, $dF/dk=0$. Hence the points of contact of the tangent planes which pass through CD are the points of intersection of the three surfaces

$$F=0,\ dF/d\gamma=0,\ dF/d\delta=0 \qquad (2)$$

and their number is equal to $n(n-1)^2$, which is the value of m for an anautotomic surface. The elimination of (α, β) between (2) will furnish a binary quantic in (γ, δ) the degree of which is equal to the class of the surface.

It is obvious from geometrical considerations that a conic node must diminish the class by 2. The equation of a cubic having a binode B_3 is $\alpha\gamma\delta+u_3=0$, where u_3 is a ternary cubic in (β, γ, δ). Differentiating with respect to γ and δ, and then putting $\delta=\lambda\gamma$, we obtain

$$\left.\begin{array}{r} \lambda\alpha\gamma^2+u'_3=0 \\ \lambda\alpha\gamma+du'_3/d\gamma=0 \\ \alpha\gamma+du'_3/d\delta=0 \end{array}\right\} \qquad (3)$$

where the accents denote what the quantities become when δ is put equal to $\lambda\gamma$ after differentiation. Equations (3) are those of the sections of the cubic and the polar quadrics of C and D by *any* plane through AB; and since they intersect in three coincident points at A, $m=12-3=9$.

The equation of a cubic having a binode B_4 at A is

$$\alpha\gamma\delta + \beta^2 v_1 + \beta v_2 + v_3 = 0 \qquad (4)$$

where v_n is a *binary* quantic in (γ, δ). Let $v'_n=dv_n/d\gamma$, $v''_n=dv_n/d\delta$. Differentiating (4) with respect to γ and δ, and eliminating α, we obtain

$$\left.\begin{array}{r} \beta^2(v_1-\gamma v'_1) + \beta(v_2-\gamma v'_2) + v_3-\gamma v'_3=0 \\ \beta^2(v_1-\delta v''_1) + \beta(v_2-\delta v''_2) + v_3-\delta v''_3=0 \end{array}\right\} \qquad (5)$$

The eliminant of (5) is a binary octavic in (γ, δ); whence B_4 reduces the class by 4.

The classes of all the remaining species may be found by means of the eliminant of (5), or directly from their equations.

A. B. BASSET.

September 6.

Ben Nevis Observatory and the Argentine Republic.

NEWS has reached me here from the office of the Scottish National Antarctic Expedition in Edinburgh of the appointment of almost the whole of the Ben Nevis Observatory staff to the Argentine Meteorological Office, including the superintendent, Mr. Angus Rankin, who has been associated with the observatory for more than twenty years, Mr. Robert Macdougal, for many years assistant, and Mr. Bee.

It may be remembered that in March, 1903, the Scottish National Antarctic Expedition set up a first-class meteorological and magnetical station in the South Orkneys, at Scotia Bay, and that, after the wintering of the *Scotia*, I offered to hand over the station, including Omond House and Copeland Observatory, to the Argentine Government with eighteen months' provisions, as well as to give a passage on board the *Scotia* to Argentine men of science if the Republic would undertake to continue the work and relieve the party the following year. This was carried through by the energy of Mr. Walter G. Davis, director of the Argentine Meteorological Office, and Mr. Robert C. Mossman, the Scottish expedition's meteorologist, was asked to continue in charge. Now Mr. Mossman has returned after two years' valuable work in the Antarctic, and the station is being kept up a third year—the first time in the history of Antarctic exploration that scientific observations have been carried on in one place for more than two years.

But the Republic is not satisfied; it is to continue the work for still another year, and is even going to increase the number of Antarctic stations. Trained men were required, and since Mr. Mossman's return he has been in communication with Mr. Davis, with the result that these three gentlemen have been appointed to carry on this work, as well as Mr. W. R. Bruce, also of Ben Nevis Observatory, who arrived in Buenos Aires three weeks ago.

The Argentine Republic must be congratulated on its enlightened perspective; but surely while doing so we must hang our heads in shame, for, while our Government has discouraged scientific research, we find this rapidly rising Republic eager to encourage it.

WILLIAM S. BRUCE.

Eggishorn. Switzerland, September 8.

Properties of Photographic Plates Exposed to Light.

IN May, 1904, I exposed an ordinary sensitised ½ plate (20th Century Rapid) to daylight. It was so placed that the light had to pass through a window before falling upon the plate. The day was cloudy and dull, without sun, and the time of exposure was from two to four p.m.

In the meantime I placed an unexposed plate in a box, and upon it a steel pair of scissors. Then taking the exposed plate I placed it above the unexposed plate with the scissors in between and in contact with the sensitised sides of both plates.

After closing the box and wrapping up to exclude light, I put it away for six weeks.

At the end of this period I developed (with MQ) the unexposed plate, and found, as I had hoped, a radiograph of the scissors; then developing the exposed plate it appeared, if anything, to be less dark than the unexposed plate, but without any image.

During 1904 I repeated the experiment several times, varying the time of exposure and letting the light pass through thicker glass, also developing at shorter intervals, the days in every case being cloudy as in the first case. With one slight exception, I failed to obtain any result.

This year I put down three other pairs under the same conditions as the first experiment of 1904, but, if anything, the day, though cloudy, was much brighter. With these I obtained three good results, one of which I unfortunately spoilt in developing.

At present I have five or six other pairs which will be ready for development in four or five weeks' time. In these cases the day was bright sunshine, so that perhaps better results may be expected.

L. H. WINN.

Coombe College, Luton Road, Harpenden.

CAUSE AND PREVENTION OF DUST FROM AUTOMOBILES.

AT the present time by far the most serious problem which the automobilist has to face is the abatement of the "dust nuisance." A great deal of bad feeling has arisen against the motorist on account of the dust which he too frequently produces, and there is no doubt that there are very good grounds for the irritation which has arisen, more particularly in agricultural districts. Farming in this country, at the best of times, is not in a prosperous condition, and a farmer does not view with any kindly eye a further reduction in his produce through the effects of dust. Apart from that, however, dust may cause a great deal of personal discomfort to other users of the roads; but this phase of the question would, perhaps, not require very serious consideration were it not that dust of this nature is apt to carry disease, and to lower the health of the poorer part of our population living along the main thoroughfares. As such matters may lead to serious opposition to automobilism, and possibly to further legal restrictions, all tending to hamper a growing and very important industry in this country, it is becoming imperative to see what can be done to minimise a nuisance of this kind.

At present there are two distinct methods of tackling the problem. One is to treat the roads, or construct them, in some way so that they no longer give rise to dust. The other is to so alter the construction of the car that dust, if it exists, will not be raised to a serious extent. These two methods we will now consider.

(1) *Special Treatment of the Roads.*

Undoubtedly proper treatment of the roads, if something permanent and at the same time not costly could be devised, would be the most effective solution of the problem. If, for example, the surface could remain moist, there would obviously be no dust. But treatment with the ordinary watering-cart is very transient; moreover, it is destructive, for the water, as a rule, is used in excess. The use of a deliquescent substance, such as calcium chloride, naturally suggests itself. But in order to be effective the solution would have to be above a certain strength, and probably a little wet weather would remove so much of the deliquescent material that re-treatment would be necessary very soon.

A number of solutions are now on the market for the more or less temporary treatment of roads. Perhaps the best known is Westrumite, containing chiefly petroleum and ammonia, the product being completely miscible with water. It has been used extensively as a temporary measure. Experiments by the Scottish Automobile Club show that the effect remains for a considerable time. Three stretches of road, each about half a mile in length, comprising metalling in three different stages of wear, were selected. These were thoroughly cleaned and treated with a 10 per cent. solution of Westrumite. This was repeated after three days, and, as very heavy rain fell soon after, a solution of the same strength was applied a third time. The result appears to have been very satisfactory. Absolutely no dust was raised by vehicles of any description passing over the road for a very considerable time after the application, and even after three months the dust was nothing to speak of. On the metalling that had been worn the dust was found to be greater. The permanency of the result probably depends on the amount of traffic, as results elsewhere have not always been so satisfactory.

Other preparations of a similar character have

been devised, such as Akonia and Dustroyd. The latter is a liquid manufactured from tar, and as it is not soluble in water it should have the advantage of greater permanence, being less affected by rain than are soluble preparations. It is said to give an asphaltic surface to the roads.

A more permanent style of treatment is by means of oil. So far this method has not received much attention in this country, but in America it is being tried on an extensive scale. This is the case at Los Angeles, Cal. The secretary of the Chamber of Commerce of that city gives the following details in a report on the subject:—

"For the past four or five years the use of oil on our roadways has been increasing rapidly, and is now considered the best method for laying the dust, as well as of making a serviceable roadway. It has been taken up by the different boards of supervisors in the surrounding counties as well as by the superintendent of streets in Los Angeles, and we have now in the neighbourhood 300 or 400 miles of oiled roads within a radius of 60 miles of the city. It has been found, when properly applied and the necessary attention given to it, that it forms a smooth durable surface; and in one case of a road with a 6 per cent. grade treated with oil, it was found after a heavy rainstorm the road had not cut or washed, but on a road in the same neighbourhood under the same conditions not treated with oil it became impassable.

"The process of preparation varies considerably according to the opinions and experience of the different workers, as well as with the different material of which the road bed is composed. Some officials have claimed that a very sandy road would not be benefited with oil, but by repeated experiment it has been found that by putting on a very heavy coat of oil the loose sand has taken it up, and by continual application a very fair road bed has been made out of what was almost impassable sand. In some instances sandy roads have been first crowned up with a heavier soil or with clay, making a firm foundation, and then treated with oil, thus making as good a road as in other sections where the land is heavier. In some localities, where oil has been used for some time and careful attention given to repairs and renewal, the roads have become as smooth and hard as asphalt pavements and without the disadvantage of dust. In preparing an ordinary road, in some instances the surface has been loosened by a machine carrying something in the nature of a rake, for the purpose of being able thereby to mix the oil with the surface dirt. In others where the soil is heavy and packed hard, it has been covered with oil and then a thin coating of light sand is sprinkled over this, which causes the whole to cement together, forming a hard surface. For roads of this nature, that is, with a hard surface, it has been found preferable in many cases to use a light gravity oil, which is absorbed readily by the earth. In cases of light or sandy soil, it is contended by many that the heavier oils carrying more asphalt in their composition are more desirable and more effectual for the purpose.

"It is a hard matter to give any definite figures as to the cost of treating the roads, for the reason that conditions differ and prices of material vary in the different localities; but from the figures given by some of our supervisors it seems that it takes from 75 to 250 barrels of oil per mile for the first treatment, according to the character of the soil. About one-third of the original amount is sufficient for the second year, and thereafter in constantly decreasing amounts. It is stated that the average cost, taking the first application and the later attention, should not exceed 20*l.* per year per mile. It is authoritatively claimed that treatment by oil is much less expensive, even at the outset, than the use of water in laying the dust, and at the same time is enduring."

Mr. Lyle Rathbone, in a paper read before the Liverpool Self-propelled Traffic Association this year, gives an account of experiments with oil carried out on the roads at Liverpool. The oils used were hot and cold creosote oil by itself, creosote oil mixed with small proportions of pitch, resin, or tallow respectively, hot coal tar, cheap waste oil from coal tar, common petroleum, and crude Texas petroleum. The general results do not appear to be anything like so permanent as those obtained in America referred to above. They were satisfactory as far as they went, the tendency being for the road surfaces to be preserved, to dry more quickly, and to be cleaner. No very conclusive result as to the best oil seems to have been reached. Creosote oil with resin gave the cleanest and best appearance, and ordinary petroleum was the least lasting. Heavy coal tar waste oil lasted longer than creosote, and was very much cheaper; a single coat kept the surface in good order for about three weeks, and two coats for about five weeks.

Experiments by the Scottish Automobile Club showed that crude oil was most effective. It was poured on to the cleaned road surface by means of cans, and brushed over so as to saturate the surface uniformly. In about twelve hours the surface was dry enough for traffic. The cost per mile of road of fair average width was about 20*l.*, which may seem costly, but the method has the great advantage that a single application is sufficient for a season, and against this cost must be set a saving in other ways. It is to be hoped that more extensive experiments

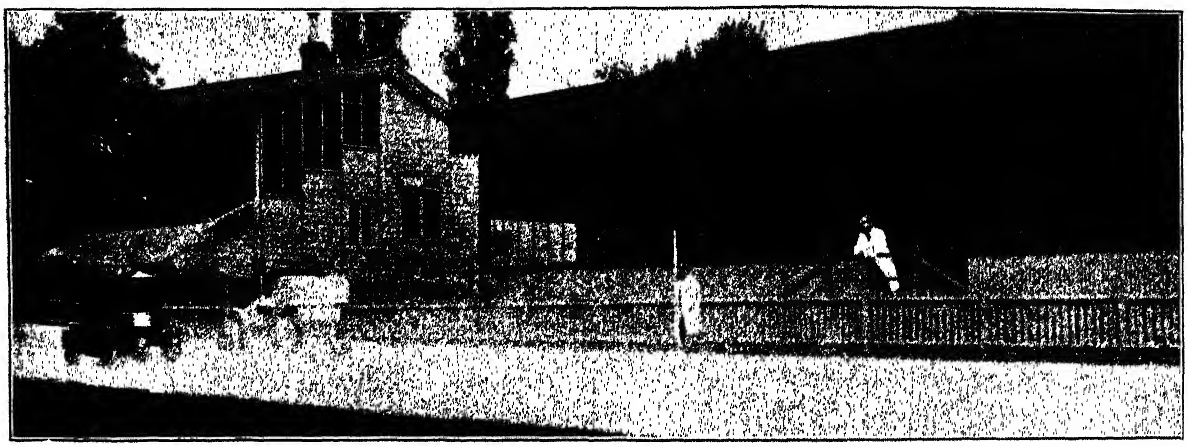

FIG. 1.—Test of a dustless car running over flour at the Crystal Palace. From the *Automobile Club Journal.*

will be carried out on these lines, for the results seem rather contradictory, and there are probably a good many factors to be observed.

In the methods so far referred to, attempts are made to improve the roads with their present mode of construction. But it would be more rational to use materials in road-making that would not give rise to dust; for example, with materials of a viscous nature. Tar very naturally suggests itself, and a good many experiments have been made either by mixing it with road materials or by applying it hot as a coating. Mr. Scott Montagu, in a paper recently read before the Automobile Club, gives several instances in which the tarring of roads has proved effective. It is perhaps a little early to say whether this treatment remains satisfactory under all conditions, or whether it may after a time give rise to unpleasant mud in wet weather under certain conditions.

In order to obtain a permanent result it seems necessary that the crust of the roadway should be really waterproof to a fair depth, so that dust-forming materials cannot work up. This result can only be obtained by combining the tar with the materials used in construction. It is useless, however, to tar such materials as granite or syenite, because the tar remains only on the outside, and as the material is worn the tar becomes ineffective. For that reason Mr. E. P. Hooley uses furnace slag, which is very porous, and produces a material which he has named "Tarmac." The slag is taken hot from the furnaces, broken, and thrown into tanks of tar. Upon cooling, the tar becomes absorbed, and the slag is thoroughly impregnated, so that if the pieces are broken further a tarred surface is still found. In other words, the material is such that it cannot give rise to dust. It is used in construction, like other materials, to a depth of several inches. The initial cost is rather heavier than for a macadam road, but this appears to be more than counterbalanced by the greater durability and the fact that a waterproof road is obtained free from dust and requiring much less cleaning than the usual macadam.

FIG. 2.—Test of a dusty car running over flour at the Crystal Palace. From the *Automobile Club Journal.*

(2) *Design of the Car.*

Although a permanently good road may be made by the use of such materials as Tarmac, and dusty roads may be cured temporarily by various means, yet such measures can be taken only over a small proportion of our roads owing to the cost. In towns and large villages the roads might be suitably treated; but the average motorist seeks the country, and the greater part of the routes which he wishes to traverse will not pay for any special treatment. It therefore becomes very important to modify the design of cars so that the dust raised may be reduced to a minimum, and also, if possible, to find some simple means of checking the dust in the case of cars already in use.

One of the simplest defects to remedy is the direction of the exhaust, which is sometimes pointed downwards. In such a case the dust raised by the exhaust alone may be considerable, and an improvement may be made very simply. It has even been proposed to use the exhaust, suitably directed, for laying the dust which is otherwise raised by the car; and M. Baudry de Saunier, editor of *La Vie Automobile,* vouches for the efficiency of the Feugère system, as it is called. The exhaust is discharged from a horizontal pipe taken across the back of the car, having a line of holes along its length. Thus a number of jets in the same plane is formed, and the pipe is so mounted that the angle at which these jets impinge on the roadway may be varied so as to be as effective as possible. Naturally, the less fluctuating the stream of exhaust gases the better for such a purpose, and the result is said to have been much more satisfactory on a four-cylinder than on a single-cylinder car. I have not had an opportunity of seeing this device in action.

Speaking generally, and leaving such special points as direction of exhaust out of account, it may be said that the dust is raised by the tyres, and is then scattered by the air currents produced by the body. In other words, if the body were moved along the road at its normal height, supported by other means than the wheels, very little dust would result. But it is equally true that if the wheels could be run without the body there would not be much cause for complaint as to dust. By *body* is here meant the whole structure, apart from the wheels, so that the term is more comprehensive than usual. The passage of a car body through the air necessarily creates a great deal of disturbance, and the extent to which the air near the ground is disturbed must depend to a great extent upon the shape of the body. The less the disturbance, the less will the dust be formed into a cloud.

In 1903, the Automobile Club tested the dust-raising qualities of a large number of cars. Each car was run at twenty miles per hour over a patch of flour on the cycle track at the Crystal Palace. The flour was kept at a definite thickness, and as each car passed it was photographed. These photographs gave a permanent record of the dust cloud raised by each car, enabling the committee to classify the cars in the order of merit. The records so obtained gave a great deal of useful information, and it was recognised that this method of testing was far more satisfactory than optical observations, because an observer has a good deal of difficulty in retaining a mental picture of what may be termed a standard car as regards dust.

In a paper read in 1903 before the Automobile Club, Colonel Crompton and Mr. Crawley came to the following conclusions, based on these experiments:—Hard tyres are better than soft; narrow tyres are better than broad; neither have a preponderating influence; flaring mud-guards are probably bad, especially if they come low down; cars which are low underneath are worse than cars a long way off the ground; but smoothness of bottom-shape and absence of forward coning are infinitely more important. There is strong evidence that it is desirable that the car should slope upwards towards the back. At the same time, the authors point out that "a low car is not necessarily a dusty one, nor is a high car necessarily dustless."

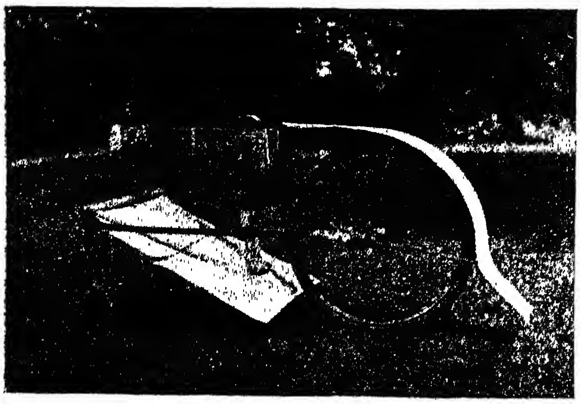

FIG. 3.—Experimental tricycle.

Figs. 1 and 2, which are reproductions of photographs taken during the Crystal Palace tests, show the great difference that already exists between different makes of car, the first being of a comparatively dustless car, and the second of a very dusty car, both running at twenty miles per hour, the pace being given by a "speed car" running alongside. It will be seen that it is possible to make cars comparatively dustless, though the means of doing so are not yet well understood.

In approaching the problem, it is necessary to give up all preconceived ideas, for the practical results by no means always agree with what would theoretically be expected. If a dusty car and a comparatively dustless car are examined and compared, it is often not at all easy to say why the one is more dusty than the other. People are apt to have the idea that comparatively small differences in the car body are important. Last year, however, the Automobile Club carried out a series of experiments on different shapes of body, and these showed that the dust raised did not depend to any great extent upon the shape, at least as regards small modifications of the upper structure. An irregular shape under the chassis is no doubt bad, and the transverse tool-box carried low down at the back of the car, which is frequently seen, is certainly harmful.

The investigation of the problem by means of a car is difficult, owing to the number of variables. For example, the experimental car may be a "medium" dust-raiser, and, if any modification is made, the effect may be masked to a considerable extent by other factors which we may not be able to control. Therefore it would be better, if possible, to study the problem with a much simpler apparatus, so that any one variable might be taken in turn without difficulty. In the hope of doing something in this way, I have recently carried out experiments on an elementary form of tricycle, which is shown in Fig. 3. This is drawn over a track laid with

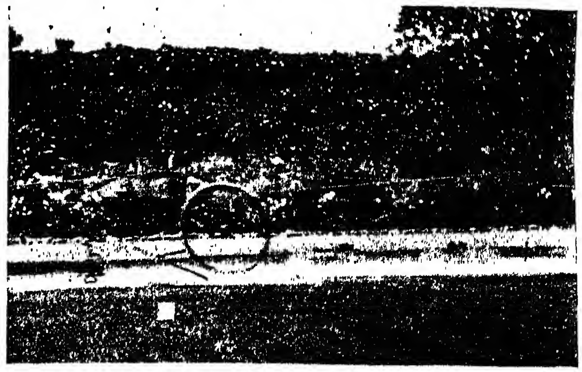

FIG. 4.—Dust thrown up by a tyre pumped hard.

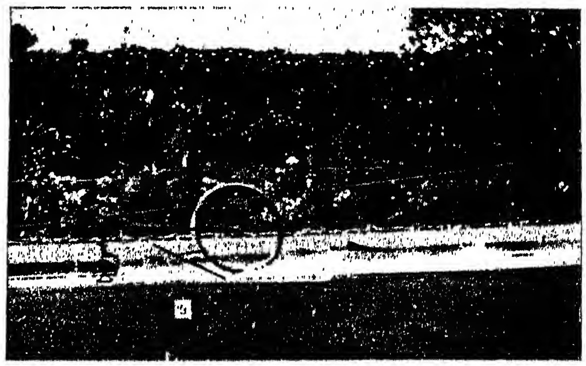

FIG. 5.—Dust thrown up by a very soft tyre.

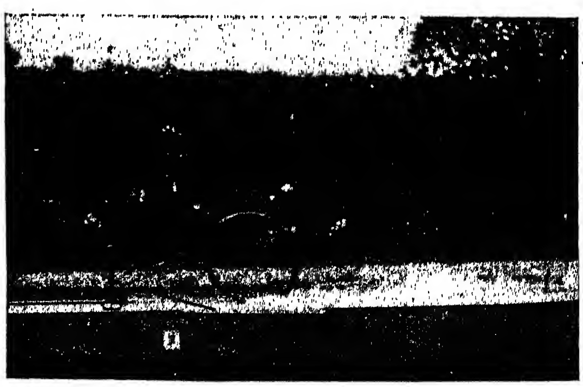

FIG. 6.—Dust thrown up by a very soft tyre loaded with 12 lbs.

flour at, say, fifteen to twenty miles per hour, and photographs are automatically taken to show how much dust is raised by the large wheel, which is an ordinary bicycle wheel. The flour is laid only along the centre of the track, so that the bicycle wheel is the only one that causes any disturbance. As the framework is of very simple construction, it may be regarded as causing no serious disturbance in the air, unless it is supplemented by some form of body. In the illustration it is shown provided with a mud-guard and an inclined plane; these, and any other "bodies," are easily made of cardboard, and a number of experiments can be carried out in a comparatively short time.

By stripping the frame, the action of the tyre alone, apart from any body, may be easily investigated in a way which is impossible with a car having four wheels with a conflicting set of mud-guards, or a body which will affect the back wheels quite differently from the front wheels. Thus Fig. 4 shows the dust thrown up by a tyre pumped hard, from

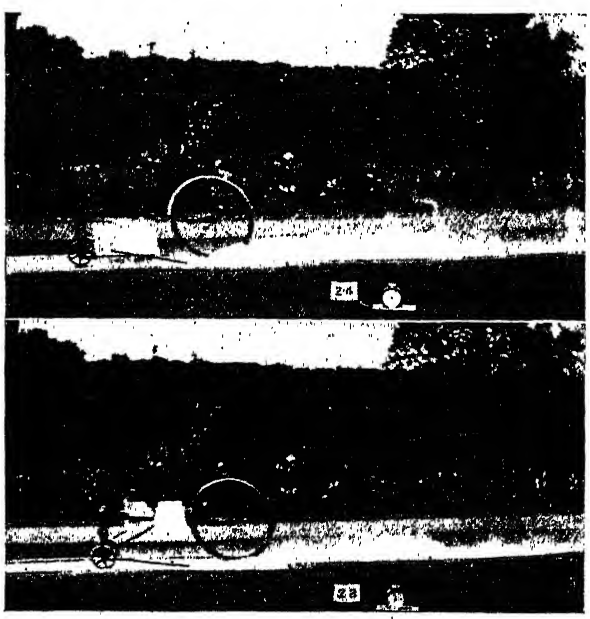

FIG. 7.—Dust cloud formed by a square box 3 inches off the ground.
FIG. 8.—Dust cloud formed by a square box 9 inches off the ground.

which it will be seen that the dust is only slight. In Fig. 5 the effect is shown of a very soft tyre, the dust being a good deal more. In both these photographs the tyre was unloaded, except for the proportion of the frame which it had to bear. But in Fig. 6 the effect is shown of a load of 12 lb. on the tyre, and it is seen that the dust raised is much increased.

Although, from the point of view of raising dust, the tyres may not be so important as the body, their action does seem to be important enough to warrant more careful investigation. They are capable, in themselves, of raising a good deal of dust, as is often to be seen in the case of bicycles. Very possibly dust is carried up by tyres through a kind of suction, and this may vary a good deal with the design. Now that there are so many different tyres, including non-skidding bands, on the market, there is likely to be a considerable difference in the various types as regards dust. In the photographs which are reproduced, the wheel is equivalent to the front wheels of a car, as there is no driving force on the tyre. In the case of wheels which are drivers, there will be a certain amount of slip of one kind or another, and the dust raised is likely to be greater; but, actually, there

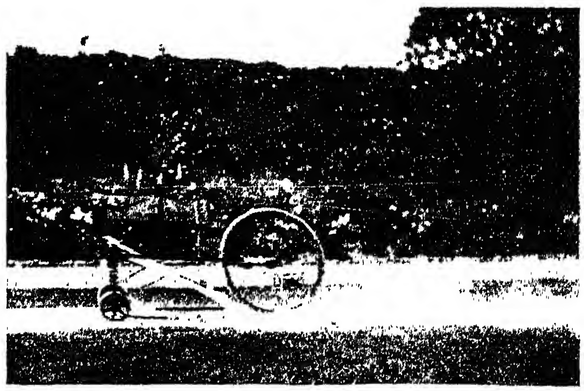

FIG. 9.—Effect of an inclined plane.

does not seem to be any very great difference between drivers and non-drivers—at least there is much less than would be expected.

As regards "bodies," Figs. 7 and 8 show the effect of allowing a square box, 18 inches long by 20 inches wide and 12 inches deep, to precede the wheel. In Fig. 7, which shows a large cloud of dust, the box is only 3 inches off the ground; but in Fig. 8 it is 9 inches above the ground. In the latter there is still a lot of disturbance, which fact is of interest, seeing that the bodies of certain cars are brought down to within about 6 inches of the ground. These illustrations and those following are comparable with Fig. 6, the tyre being loaded and soft, and the motion being always from right to left. In Fig. 9 is seen the effect of an inclined plane, so inclined that the air is severely thrown down on to the track. It is a little surprising to notice that the effect of the plane is not nearly so serious as that of the box seen in the two preceding illustrations, although the box and plane are about the same in width, and the plane, which is carried down to within about 4 inches of the ground, is of considerable length. It may be, therefore, that the inclination of the under surface of a car body is not of much importance after all. In Fig. 10 is shown the very marked disturbance caused by a vertical card, 12 inches square, fixed

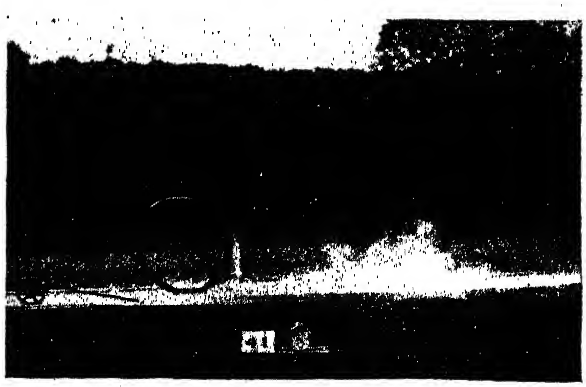

FIG. 10.—Effect of a vertical plane behind the wheel.

behind the wheel; this is akin to the tool-box which is often carried low down behind a car, and is generally recognised as having a bad effect.

In the present article it is impossible to go further into details. The apparatus as illustrated is rather crude and elementary, but I think enough has been said to justify the view that a good deal of useful work might be done by working with apparatus on these lines.

W. R. COOPER.

THE INTERNATIONAL UNION FOR COOPERATION IN SOLAR RESEARCH.

A CONFERENCE of the International Union for Cooperation in Solar Research will be held on September 27 at New College, Oxford, by invitation of the warden and fellows of the college. The following delegates of societies constituting the union have signified their intention of being present:—

From the United States, Profs. Hale and Campbell; from France, Messrs. Janssen, Deslandres, Fabry, Perot, and the Comte de la Baume Pluvinel; from Russia, M. Belopolski; from Germany, Prof. H. Kayser; from Holland, Prof. H. H. Julius; from Sweden, Prof. Knut Ångström; from Switzerland, Prof. A. Wolfer; from Austria, as representative of the International Association of Academies, Prof. Edmund Weiss. Great Britain will be represented by Profs. Turner, Schuster, and Fowler, Father Cortie, Mr. W. E. Wilson, Major Hills, Dr. W. J. S. Lockyer, and Dr. Halm. The subjects of discussion will include the following:—

The fixing of standards of wave-length in spectroscopic research, cooperation in the measurement of the intensity of solar radiation, cooperation in recording solar phenomena by means of photographs of the disc, spectroheliograph records and observations at the limb of the sun.

The foreign savants will be lodged at and entertained by New College. On Friday, September 29, the president of the Astronomical Society and Mrs. Maw will give a reception at their residence in London, and for the following day invitations to visit the observatories at Cambridge have been received from Sir Robert Ball and Mr. Newall. Prof. Schuster is acting as chairman of the executive committee which was appointed last year at the first conference of the union held at St. Louis.

NOTES.

THE meeting of the International Meteorological Conference at Innsbruck was opened on Saturday last, September 9, and the full sittings began on Monday. The following is a list of members attending the conference:—F. Åckerblom, Upsala; Rev. P. J. Algué, S.J., Manila; A. Angot, Paris; R. Assmann, Lindenberg bei Breskow; A. Belar, Laibach; W. v. Bezold, Berlin; B. Brunhes, Puy de Dôme; V. Carlheim-Gyllensköld, Stockholm; V. Conrad, Vienna; P. M. Dechevrens, Jersey; E. Durand-Gréville, Mentone; Sir John Eliot, London; F. Erk, Munich; E. van Everdingen, de Bilt; G. Fineman, Stockholm; Rev. P. L. Froc, S.J., Zi-ka-wei; V. Gama, Tacubaya Obs., Mexico; G. Greim, Darmstadt; J. Hann, Vienna; G. Hellmann, Berlin; E. Hepites, Bukarest; H. Hergesell, Strassburg; H. H. Hildebrandsson, Upsala; W. Kesslitz, Pola; N. v. Konkoly, Budapest; W. Köppen, Hamburg; A. Lancaster, Uccle; W. Láska, Lemberg; E. Lauda, Vienna; J. Liznar, Vienna; Sir N. Lockyer, London; W. J. S. Lockyer, London; J. H. Lyons, Cairo; E. Mazelle, Triest; H. Mohn, Christiania; A. Mohorovičić, Agram; L. Moore, Washington; M. Nedelkovitch, Belgrade; L. Palazzo, Rome; A. Paulsen, Copenhagen; J. M. Pernter, Vienna; F. C. A. Pockels, Heidelberg; P. Polis, Aachen; G. B. Rizzo, Messina; A. L. Rotch, Boston; P. v. Rudzki, Cracow; M. Rykatchew, Petersburg; A. Schmidt, Potsdam; A. Schmidt, Stuttgart; P. Schreiber, Dresden; Ch. Schultheiss, Karlsruhe; Rev. P. Th. Schwarz, Kremsmünster; W. N. Shaw, London; A. Silvado, Rio de Janeiro; R. F. Stupart, Toronto; L. Teisserenc de Bort, Trappes; W. Trabert, Innsbruck; J. Valentin, Vienna; J. Violle, Paris. The members of the Solar Commission are:—M. Angot, Sir John Eliot, Prof. Hann, Sir N. Lockyer (president), Dr. Lockyer, Captain Lyons, Prof. Pernter, Prof. Rizzo, Dr. Rotch, Dr. Shaw, M. Teisserenc de Bort, Dr. Konkoly.

THE Carnegie Institution, Washington, sent Profs. F. Elster and H. Geitel and Herr F. Harms to Palma to make observations of the electric conditions of the atmosphere during the recent solar eclipse. By means of a self-registering electrometer, the variation of atmospheric electricity was photographically recorded, and a series of points of the same curve was taken simultaneously by eye-readings. The ionisation of the air was studied by a "Zerstreuungsapparat," and also by an "Ebert's Föncounter." Besides these observations, exact measurements of the intensity of the solar radiation within the short wave-lengths were carried out, a peculiar kind of photometer having been prepared for this purpose. It is based upon the property possessed by clean surfaces of the alkaline metals of emitting kathode rays of a density proportional to the intensity of the incident light; by these rays the small residue of gas contained in a vacuum glass bulb is rendered conductive, and a circuit of a current is closed, the intensity of which may be read by means of a d'Arsonval galvanometer. In the apparatus alluded to the sensitive surface consisted of a thin layer of pure rubidium metal. An accuracy of ½ per cent. to 1 per cent. was easily obtained. By a blue Jena glass rays of long wavelength are absorbed before reaching the rubidium surface, so only the blue and violet, and partially the ultra-violet, region of the spectrum remains, and these are the radiations which may be supposed to have an ionising effect on the atmospheric air. The results, as well as the description of the apparatus, will be published in the reports of the Carnegie Institution. Unfortunately the observations, like all others in Spain, suffered from the bad weather conditions. On the day of the eclipse rain fell during the morning; consequently it cannot be considered as undisturbed with regard to atmospheric electricity. The measurements of the solar radiation were possible in a continuous series only from the first contact to the end of totality; the decrease of illumination, therefore, was determined in a satisfactory manner and without any gaps. On the other hand, clouds prevented any reading being taken during the increase of light after totality.

THE photographs of the total solar eclipse, taken by the Solar Physics Observatory Expedition at Palma, have proved to be better than was expected from the state of the sky during totality. A fine picture of the corona was secured with the long-focus mirror, but the clouds were too dense for successful tri-colour photographs to be obtained.

THE visit of the members of the British Association to the Victoria Falls on September 12 was made the occasion of the formal opening of the bridge over the falls, by Prof. G. H. Darwin, president of the association. In declaring the bridge open, Reuter's Agency reports Prof. Darwin to have remarked that the great enterprise of the Cape to Cairo Railway, of which the bridge is a part, had

become possible by the influence of steam. He could not refrain from quoting the remarkable forecast written by his great grandfather, Erasmus Darwin, in 1785:—

> Soon shall they arm unconquered steam afar,
> Urge the slow barge and draw the flying car.

How little could the writer of these lines have foreseen that his great grandson would have the honour of declaring a railway bridge open in the heart of Equatorial Africa. Yet another interesting point was that this enterprise had rendered possible a purely scientific enterprise. He referred to the great survey of an arc of meridian which was due to the insight of Sir David Gill.

IT is announced that the Emperor of Austria has made Dr. Karl Toldt, professor of anatomy in the University of Vienna, a life member of the Austrian House of Lords.

THE Harben lectures will be delivered in the lecture room of the Royal Institute of Public Health on October 10, 12, and 17 by Prof. T. Oliver. The subject of the lectures will be some of the maladies caused by the air breathed in the home, the factory, and the mine, including a description of caisson disease or compressed air illness.

A TELEGRAM to the *New York Sun* from Honolulu states that the steamship *Sierra*, which arrived at New York on September 6 from Australia, reports that a volcanic eruption has occurred on the island of Savaii, the largest of the Samoan group.

THE Arctic expedition of the Duc d'Orléans arrived at Ostend on September 12 on board the *Belgica*. M. de Gerlache, the commander of the expedition, said that the duke and himself were delighted with the results attained. They had been able to follow the pack ice the whole way from Spitsbergen to Greenland. The expedition has brought back a number of cases containing collections of scientific value.

WE regret to have to record the death of Mr. H. R. Noble, a past student in physics at University College, London. Mr. Noble had shown the possession of great experimental ability in connection with various investigations published by the Royal Society, especially by his work on the question of the relative movement of ether and matter. He had gained an 1851 scholarship, and had gone to Giessen to work under Dr. Drude when failing health compelled him to relinquish this work. Mr. Noble was very popular amongst his fellow-students and teachers at University College, and the news of his early death will be received with great regret.

IT was stated recently by the *British Medical Journal* that a member of the Brazilian Chamber of Deputies had proposed that a prize of 400,000*l*. should be offered for the discovery of a certain method of stamping out consumption. It is now understood by our contemporary that the offer, which has been approved by the Brazilian Parliament, is larger in scope than was supposed, for it appears that the prize will be given to anyone, native or foreign, who shall discover a certain means of prevention or cure of syphilis, tuberculosis, or cancer. The Brazilian Minister of the Interior will, it is said, refer the proposal to a committee composed of a representative of the National Academy of Medicine, and four other members of kindred bodies in France, England, Germany, and Italy. The Brazilian Government will regulate the meetings of the committee.

THE Paris correspondent of the *Times* states that one of the most interesting features of the International Congress on Tuberculosis, to be held at the Grand Palais on October 2–7, will be a museum and international exhibition of tuberculosis. The Paris Municipal Council has agreed to retain a considerable part of the scientific objects in the exhibition for a permanent free museum similar to that established by the Berlin Municipality at Charlottenburg. The opening meeting of the congress will be presided over by the President of the Republic, and attended by numerous French and foreign delegates, including leading men of science. The congress will be divided into four sections, that of medical pathology being presided over by Prof. Bouchard, that of surgical pathology by Prof. Lannelongue, that of the preservation and assistance of infant life by Prof. Grancher, while that of the preservation and assistance of adult life and social hygiene will be under the joint presidency of Prof. Landouzy and Senator Paul Strauss. The acting president and vice-presidents of the congress are Dr. Hérard, of the Academy of Medicine, and Profs. Chauveau and Brouardel, of the Institut de France. Dr. C. Theodore Williams and Dr. H. T. Bulstrode have been appointed by the Government the British delegates to the congress.

A SEVERE earthquake disturbed a large part of Italy and Sicily on September 8, causing much damage and the loss of hundreds of lives. The region most affected was in the vicinity of Monteleone, Calabria. The shock caused damage so far as Sant Agata di Saro, Roggiano, and Gravigna (province of Cosenza) and Sicily in the south, and there was a sensible seismic movement in the north so far as the province of Palermo, Saserno, Basilicata, Puglia, Bari, and Lecce, and in the south over the whole eastern coast of Sicily. The following summary of Reuter's messages contains the essential facts relating to the disturbance:—*Reggio, Calabria, September* 8.—Very severe earthquake at 2.44 a.m. *September* 9.—Two undulating earthquake shocks of short duration felt at 2.8 p.m. *Catanzaro, Calabria, September* 8.—Violent shock of earthquake, lasting eighteen seconds, felt at 2.55 a.m. Several walls collapsed and cracks appeared in others. *Messina, September* 8.—Very severe shock occurred at 2.43 a.m., the direction of movement being from north to south. *Rome, September* 8.—Shock felt about 2.45 a.m., followed by other shocks during the day. Public clocks stopped. *September* 9, 2 p.m.—Slight shock registered by the instruments of the observatory at Rocca di Pappa. *Martirano.*—Many killed and injured. All the buildings collapsed. *Stefanaconi.*—Many houses destroyed, and about 100 people killed. *Piscopio.*—Every house in the village in ruins, and the dead number 50. *Monteleone.*—Many houses destroyed, and about 600 lives lost in the district. *Triparni.*—Totally destroyed, and 60 people killed. *San Gregorio.*—Sixty-five deaths. *Zammaro.*—Houses destroyed. *Zungri.*—Nearly every house wrecked, and many persons killed. *Cessaniti.*—Practically all the houses destroyed. *Bratico, Sanleo, St. Costantino,* and *Conidini* totally destroyed. *Catanzaro.*—All the villages in this province seriously damaged. Several entirely destroyed. About 450 killed and 1000 injured. *San Floro.*—Houses seriously damaged. *Daffina, Daffinillo,* and *Louzione, in the district of Tropea.*—Much damage done to houses. *Fesenza.*—Shock very severe, and extensive damage done. *Syracuse* and *Catania.*—Severe shocks felt. *Castellammare, Naples,* and *Florence.*—Slight shocks.

AN article in the *Hong Kong Daily Press* by Mr. W. Kingsmill discusses the position of Ophir. He argues that the situation of Ophir and the provenance of the gold of Ophir are two distinct questions, holding with Prof. Keane that the latter came from South Africa; the

ruined cities of which are engaging the attention of the British Association and, what is more to the purpose, of trained archæologists. The original Ophir, on the other hand, Mr. Kingsmill locates at the head of the Persian Gulf, which was reached by Solomon's fleets; he makes his argument depend to some extent on a second argument to prove that the head of the gulf is the site of the Garden of Eden—a theory not improbable in itself, but apparently unconnected with the question of Ophir and the source of Solomon's treasure or of that of the earliest civilisations. Mr. Kingsmill has no evidence to show that the Jews connected the Garden of Eden with the head of the Persian Gulf, even if the myth originally referred to that area, and it is by no means clear why the Jews should associate gold with Ophir when they were, in Mr. Kingsmill's opinion, drawing their supplies of that metal from South Africa; for no evidence is produced to show that they drew gold from Mr. Kingsmill's Ophir at any time, or yet that the head of the Persian Gulf was known, much less proverbial in pre-Solomonic times as a source of gold. Mr. Kingsmill holds that Ophir, Sheba, Sofala, Havilah, &c., are one and the same, but it is scarcely sufficient to urge in proof of this that York appears twenty times in the *Times* Atlas. Needless to say, the article was written without knowing Mr. Randall MacIver's results recently described.

THE issue of the *Electrician* for September 1 contains a note by Lieut. Evans, R.E., upon some experiments made with different methods of earth connection for wireless telegraphic installations. The experiments were made with an oscillator consisting of a square copper wire capacity, 17 feet square, suspended horizontally by insulators, 14 feet above the ground. From the centre of this area, a vertical wire led to one knob of a spark gap, the other knob being connected by a similar wire to an iron-wire netting 17 feet square, suspended horizontally 2 feet above the ground, also on insulators. The current flowing in the vertical wire was measured under various conditions as regards the earthing of the iron-wire netting, and it was found that any connection of the transmitter or of the receiver with the earth was objectionable, since it greatly reduced the current flowing in the vertical wire. The most desirable form for the oscillator was, in fact, proved to be that approaching closely to a symmetrical Hertz oscillator as described by Sir Oliver Lodge in his Patent Specification, No. 11,575, of 1897. In this specification, two capacity areas, connected by self-induction coils and the receiving transformer, are clearly indicated.

As is customary, the issues of the *Lancet* and the *British Medical Journal* for September 2 are students' and educational numbers dealing with the curriculum necessary for the student of medicine, the various medical schools, books, the portals of entry into the profession, &c. The guardian of a prospective student could not do better than consult these periodicals.

THE issue of *Biologisches Centralblatt* for August 15 contains an article by Mr. A. Issakowitsch on the causes of sexual determination in water-fleas of the daphnid group, and a second by Prof. J. Lebedensky on the embryonic development of the echinoderm *Pedicellina echinata*.

FISHES from Borneo, principally from the Baram district of Sarawak, form the subject of a paper by H. W. Fowler in the July issue of the *Proceedings of the Philadelphia Academy*. Several are described as new, notably a shark belonging to the "tope" group, referred to the genus Carcharinus as *C. tephroides*.

IN a recent issue of *Science* Mr. O. A. Peterson, of the Carnegie Museum, publishes a preliminary note on remains of a huge pig-like animal allied to Entelodon from the Loup-Fork beds of Nebraska, for which the name *Dinochoerus hollandi* is suggested. The chief grounds for generic separation of the new form appear to be the geological horizon and the immense proportions of the animal, of which the skull measures no less than thirty-five inches in length. It would be interesting to ascertain what relation this monster presents to the imperfectly known Tetraconodon of the Indian Siwaliks.

THE *Fortnightly Review* and the *Independent Review* for September each publish articles on the origin of life. In the former Mr. Burke gives an account of his experiments in which, by the action of radium on bouillon, microscopic bodies, termed "radiobes," appear. These seem to divide by fission, like a micro-organism, and not by cleavage, as obtains in a crystal. Mr. Burke concludes that the continuity of structure, assimilation, and growth, and then subdivision, together with the nucleated structure as shown in a few of the best specimens (of radiobes), suggests that they are entitled to be classed amongst living things, in the sense in which we use the words, whether we call them bacteria or not. In the *Independent Review* Dr. Charlton Bastian writes on the origin and development of living matter on the earth, and discusses his theories of archebiosis and heterogenesis. With regard to the former, the formation of living matter by a process of synthesis from its primitive elements, Dr. Bastian recognises the extreme difficulty of proving it, and suggests that when the results are negative in a "sterile" fluid this may be due to the degrading influence on the fluid of the heat employed for sterilisation. But "sterile" nutrient fluids, *e.g.* egg-white and blood-serum, may be obtained without the use of any treatment. As regards heterogenesis, the development of one form of living matter into another, *e.g.* amœbæ from a bacterial zooglœa, bacteriologists will not accept this until it has been proved that the germs of the species which is supposed to have developed were not present in the original zooglœa.

THE London County Council has issued an admirable little handbook (price 1*d.*) to the case in the Horniman Museum, Forest Hill, arranged as an introduction to the study of birds' eggs. It is illustrated by six reproductions from photographs of specimens in the case intended to show variation in colouring, protective coloration, the numbers in clutches of different species, size as compared to that of the parent, form, and grain of the shell. The first two plates require, of course, to be coloured in order to bring out the distinctive features of the specimens, but this would probably have involved too great expense.

IN the report of the Manchester Museum of Owens College for 1904–5, an appeal is made to the public for aid in preventing its work and expansion being crippled for want of funds. The most important event recorded during the year under review is the presentation by Mr. J. Haworth of his collection of Egyptian antiquities, which contains a large proportion of the specimens obtained by Prof. Flinders Petrie between the years 1888 and 1897. The museum has issued as one of its handbooks the second and third parts of Mr. H. Bolton's paper on the palæontology of the Lancashire Coal-measures, originally published in the *Transactions of the Manchester Geological and Mining Society* for 1904.

IT is satisfactory to learn from *Science* that Trinity College, Connecticut, has made arrangements for establishing a floating laboratory of marine biology for the purposes

of explorations in oceanography, collecting specimens, and supplying teaching and scientific institutions with material for the study of marine organisms. A suitably fitted vessel of about 90 tons will be dispatched next summer for the Bahamas. In connection with this announcement, we may refer to a communication from Prof. M. E. Henriksen, of Ohio University, published in *Biologisches Centralblatt* of August 15, with reference to a proposal for the establishment of a biological station in Greenland, which, it is urged, would be sure to yield results of great scientific importance. "Back to nature" is the cry of the writer, who insists that biological progress now depends upon the observation of the relationship of organisms to their environment rather than on microscopic work in the laboratory.

EVER since the 'fifties, when the late Dr. H. Falconer wrote a note on the subject, strenuous efforts have been made to discover the origin of the so-called "bee-hole borings" which ruin the heart-wood of so much Burmese teak timber. Mr. E. P. Stebbing, who has been fortunate enough to discover the insect causing this serious damage, has recorded, albeit in a somewhat prolix manner, his investigations which led up to the discovery in a pamphlet published by the Calcutta Government Press under the title of "The 'Bee-hole' Borer of Teak in Burma." The offender turns out to be the larva of a large moth, which, after living for some time in the bark, when about to pupate bores large channels right into the heart-wood of saplings. As the sapling grows into a tree the borings remain in the heart, and thus completely ruin the timber for many purposes. Suggestions are made with regard to remedial measures.

THREE out of the four biological papers in the issue of the *Journal of the Straits Branch of the Royal Asiatic Society* for July are by H. N. Ridley, director of the Singapore Botanical Gardens, and relate to botanical subjects. In the first the author discusses the Gesneraceæ of the Malay Peninsula, and in the second the aroids of Borneo, while in the third he continues his descriptions of new and little known Malay plants. In the one zoological paper Mr. P. Cameron publishes a third contribution to our knowledge of the Hymenoptera of Sarawak. Among short notes, Mr. H. C. Robinson, of the Selangor Museum, records from the district where he is stationed that rare mammal the pen-tailed tree-shrew (*Ptilocercus lowei*), hitherto known only from Borneo.

THE flowering of bamboos, which a short time ago formed the subject of correspondence in NATURE, is discussed in a short article by Prof. F. A. Forel in the *Gazette de Lausanne* (August 1). In the spring a general flowering of the plants of *Bambusa gracilis,* a garden variety, took place at Morges, Canton Vaud, and flowering was observed at Nyon, Territet, Versoix, and Bex. The writer raises the questions whether the flowering is due to inherent causes or dependent upon climatic conditions, whether the seed produced is fertile, and whether all the plants die after flowering, and he requests that observations on these and similar points may be forwarded to him at the University of Lausanne.

WE have received the tenth volume of Dr. Otto Baschin's "Bibliotheca Geographica," dealing with the year 1901. The volume shows no specially new features, a certain advantage in publications of the kind, and it maintains the fulness and accuracy of its predecessors.

IN view of recent proposals to "utilise" Lake Titicaca, a paper on the basin of that lake, contributed by Mr. A. F. Bandelier to the August number of the Bulletin of the American Geographical Society, is of more than usual interest. Mr. J. Russell Smith publishes a paper on the economic importance of the plateaux in tropic America in the same number, which also contains a well illustrated mountaineering paper on the Alaskan Range by Mr. Alfred H. Brooks.

AN elaborate memoir on the commercial significance of the Suez Canal, by the late Herr Martin Voss, appears in the *Abhandlungen* of the Vienna Geographical Society. Herr Voss's paper contains much statistical and other information in small compass, and should be extremely useful, especially if studied in relation to Ungard's work on the same subject, recently published in Vienna. Herr W. Schjerning contributes to the same publication a paper on the equidistant projections used in cartography.

A DESCRIPTION of a new apparatus for demonstrating the elementary principles of mathematical geography is given by Dr. Hermann v. Graber in *Petermann's Mitteilungen.* The fundamental idea is the application of the orthogonal projection to the ordinary wire model or "tellurium," hence the name "orthogonal-tellurium." Besides being available for teaching purposes, the instrument affords the means of making angular measurements with sufficient accuracy to be of use for rough work in the field.

THE scorification assay for gold telluride ores has long been believed to give low results by reason of volatilisation, and it is now seldom used for ores of that class, the assay by crucible being supposed to be more trustworthy. The results of a careful investigation of the subject by Mr. W. F. Hillebrand and Mr. E. T. Allen, published in Bulletin No. 253 of the United States Geological Survey, show that the doubts entertained as to the accuracy of the dry method are not well founded. There is no reason to question the substantial accuracy of the crucible method. Indeed, it is clearly established that the fire assay by crucible for gold telluride ores gives results which are quite equal to those obtained by the wet way, provided due corrections are made for slag and cupel losses. The gold loss in the slag is very small, but the cupel losses are considerable, the cupellation loss of gold by volatilisation being small as compared with that by absorption.

THE Cripple Creek gold deposits in Colorado were discovered in 1891, and up to 1904 yielded 124,415,022 dollars of gold and 646,193 ounces of silver. The district was surveyed for the United States Geological Survey in 1894 by Messrs. W. Cross and R. A. F. Penrose, and at the request and at the cost of the State of Colorado it has now been re-surveyed by Messrs. W. Lindgren and F. L. Ransome, and a summary of the facts of immediate importance has been published (Bulletin No. 254). There are some 300 mines in the district, and every accessible one was examined. The deepest shaft is the Lillie, which is more than 1500 feet deep; and the productive district is covered by the area of a circle 3½ miles in diameter. An interesting feature of the ore-deposits is the occurrence of gas which in some cases issues in large volumes. Analysis shows it to consist of nitrogen, with about 20 per cent. of carbon dioxide and a small quantity of oxygen.

AT the St. Louis Exhibition last year an investigation of the coals and lignites of the United States was carried out under the direction of the director of the United States Geological Survey, the sum of 6000*l.* having been voted by Congress for the purpose. Testing machinery was generously contributed by various manufacturers, and much valuable work was done with the plant, such an elaborate series of coal analyses having never before been made in

the United States. The preliminary report on the operations of the plant, drawn up by Messrs. E. W. Parker, J. A. Holmes, and M. R. Campbell, the committee in charge, has been issued as Bulletin No. 261 of the United States Geological Survey, and is of far-reaching importance in the solution of the fuel and power problems upon which the varied industries of the United States depend. Most of the American bituminous coals and lignites can, it was found, be used as a source of power in a gas-producing plant, the power efficiency of bituminous coals when thus used being $2\frac{1}{2}$ times greater than their efficiency when used in a steam-boiler plant. Some of the lignites from undeveloped but extensive deposits in North Dakota and Texas showed unexpectedly high power-producing qualities. It was found, too, that some of the American coals and the slack produced in mining them could be made into briquettes on a commercial basis.

THE weather over the British Islands has been very unsettled during most part of the last week, rainfall being very prevalent generally; in the south of England and all the western districts the amount was much above the average. Strong gales occurred in many places, especially on the western and southern coasts, and the sea has been very rough at times. The Meteorological Office reports on Tuesday showed a considerable improvement, with clear sky over most parts of the kingdom, but a renewal of unsettled weather was anticipated in the western and northern districts. The rainfall from January 1 is still below the average in most districts, the deficiency amounting to about four inches in the north-east of England, but in the north of Scotland and Ireland the fall is considerably above the average.

THE assistant director of the Meteorological Service of Canada (Mr. B. C. Webber) has prepared a very useful paper entitled "The Gales from the Great Lakes to the Maritime Provinces." The tables show the number of areas of low barometric pressure, and gales, with information regarding them, for each month of thirty-one years (1874–1904). The results are published primarily for the use of the forecast officials in the Dominion, but they are valuable for reference by other persons. On the average, November is the stormiest month on the Great Lakes, and January in the Maritime Provinces; December and February also give a high percentage of storms. The diminution in the number of gales in March and September is opposed to the old idea of the stormy character of the periods of the equinoxes. The author states that the figures afford ample ground for suspicion that towards the maximum of sun-spots there is a maximum of low pressure areas, and that at the sun-spot minimum there is a paucity of such areas. The work has, of course, been prepared under the direction of Mr. R. F. Stupart, the director of the service.

WE have received the *Jahrbücher* of the Austrian Central Office for Meteorology and Terrestrial Magnetism for the year 1903; the work consists of two large quarto volumes, containing (1) carefully prepared results of 400 stations, and (2) special discussions, including an important contribution by M. Margueles on the energy of storms, being an elaborate mathematical analysis of that branch of the physics of the atmosphere; a discussion of much interest for weather prediction, by Dr. F. M. Exner, in connection with the behaviour of the weather during conditions of high atmospheric pressure to the north of the Alps, illustrated by a number of weather charts; also comprehensive researches relating to the formation and propagation of thunder and hail storms, by K. Prohaska. We have before directed attention to the value of the observations made at the high-level stations in the Austrian system; thirty-two of them have an altitude of 1000 to 1500 metres, fifteen others from 1500 to 2500 metres, and the Sonnblick 3106 metres. Meteorologists are much indebted to Dr. Pernter, the able director of the service, for the publication *in extenso* of the hourly results at some of these mountain stations.

MR. WM. BUTLER, of 20 Crosby Road, Southport, whose "swingcam" camera stand was referred to in NATURE of May 25 (p. 89), has sent us a series of twelve small prints of photographs of the recent partial eclipse taken by his son, who is only fifteen years of age, with the use of the apparatus. The pictures are clear, and show several phases of the partial eclipse very distinctly.

A LIST of scientific papers published by the National Physical Laboratory, or communicated by members of the staff to scientific societies or institutions, or to the technical journals, has just been issued. During 1900 and 1904, thirty-three papers on work connected with the laboratory were prepared and published by members of the staff, and in addition eleven papers were published by members of the staff independently.

MESSRS. MACMILLAN AND CO., LTD., will publish shortly "The Chemistry of the Proteids," by Dr. Gustav Mann, of the physiological laboratory at Oxford. This book is based upon the second edition of Dr. Cohnheim's "Chemie der Eiweisskörper," and has been prepared with the author's sanction. Dr. Cohnheim's work, which in its second edition has been entirely re-modelled, is of special interest to professional chemists, both organic and inorganic, but particularly to biologists, including zoologists, physiologists, and pathologists; while among the special features of Dr. Mann's book are, that for the first time the chemical derivatives of albumins and proteids are so arranged as to give a clear idea of the evolution from simple into more complex compounds, and for the first time also a very full account of the synthetic work of Curtius and Fischer is given.

OUR ASTRONOMICAL COLUMN.

NOVA AQUILÆ NO. 2.—Very little further news of Nova Aquilæ is yet to hand, but Circular No. 79 of the Kiel Centralstelle informs us that several visual observations of the star's magnitude and position have been made.

Prof. Max Wolf reports that, according to observations made at the Königstuhl Observatory on September 4, at 9h. 30·0m. (Königstuhl M.T.), the magnitude was 9·3. The position was determined as R.A. = 18h. 54m. 24s., dec. = -4° 39′ (1855).

A telephone message to Kiel from Dr. P. Guthnick on September 6 gave the following positions:—

1855.	R.A. = 18h. 54m. 25s.,	decl. =	-4° 38′·8
1905.	,, 18h. 57m. 4s.,	,,	-4° 34′·8

and stated that the magnitude on September 5 was about 10·2, whilst the star was of a yellowish colour. A star of magnitude 10·5 precedes the Nova by 10s., and is 0′·7 north of it. As the present Nova is the second known to have appeared in the constellation Aquila, it will be designated, according to precedent, Nova Aquilæ No. 2. The first Nova Aquilæ was discovered in July, 1900, on one of the Draper memorial chart plates which had been taken on July 3, 1899, and exhibited the characteristic "Nova" bright-line spectrum. The object itself was recorded for the first time, as a seventh magnitude star, on a plate taken on April 21, 1899.

VARIATION OF A NEWLY DISCOVERED ASTEROID.—According to a telegram from the Kiel Centralstelle, Dr. Palisa has found that the minor planet 1905 QY, which was discovered by Prof. Max Wolf on August 23, is subject to a remarkable fluctuation of magnitude. When discovered,

this asteroid had a magnitude of 11·3, and on August 31 Dr. Palisa recorded it as being of the eleventh magnitude; at 11h. 44m. (Vienna M.T.) on September 5, however, it had sunk to the twelfth.

The position of this body at 11h. 39·9m. (Königstuhl M.T.) on August 23 was R.A.=22h. 37·9m., dec.=$-7° 55'$, and on September 5d. 11h. 4·4m. (Vienna M.T.) R.A.=22h. 27m. 47·3s., dec.=$-9° 5' 45''$.

INTERPRETATION OF SPECTROHELIOGRAPH PICTURES.—In No. 4044 of the *Astronomische Nachrichten*, M. N. Donitch discusses the results obtained by Messrs. Hale and Ellerman, regarding the different chromospheric layers shown on their spectroheliograph negatives, in a new light. He points out that in spectrograms of the chromosphere taken during total eclipses of the sun, the lower layers of the eruptions, *i.e.* those nearer to the moon's limb, appear to be the most extensive, but in Prof. Hale's photographs (plate v., No. 1, vol. xix., of the *Astrophysical Journal*) the opposite appears to be the case, the higher, less dense layers being more extensive than those near to the photosphere.

This discordance between the two results is, in the opinion of M. Donitch, only apparent, and may be explained by the suggestions he advances. He assumes that the inequalities on the surface of the photosphere are so small as to be incomparable with those in the layers of calcium vapour which overlay it. Where this vapour is thin it will only produce the ordinary narrow reversal, producing on the negative a calcium area which is at a low pressure, and, therefore, according to Messrs. Hale and Ellerman, is situated in the upper regions of the chromosphere. This same reversal is also shown by the vapours, which are, in reality, at a greater elevation, so that, using the monochromatic reversal, one obtains on the photograph the forms of the calcium clouds of which the temperature and pressure are relatively low, whatever may be their elevation above the photosphere. For this reason, as M. Donitch believes, the first photograph, which shows more extensive areas of calcium vapour, and according to the Yerkes observers represents simply the upper layers of the disturbed areas, really also represents the thinner extensive layers of vapour which are shown on eclipse spectrograms as the broad bases of the eruptions.

A second photograph taken with the secondary slit set on the *broadened* H reversal (λ=396·2 $\mu\mu$) only registers those layers of calcium vapour which, being part of a thick layer, are subjected to a sufficient difference of temperature and pressure to produce the broadening; and these may, in many cases, be at a greater elevation than the thin layers shown as part of the "calcium" area on the first photograph.

Similarly in regard to the two photographs shown on plate viii. of Messrs. Hale and Ellerman's paper, M. Donitch believes that it is the second, taken with the secondary slit set at λ 3968·6, that reveals the general distribution of the vapours in projection, whereas the first only reproduces the higher agglomerations of the vapour which dominates the lower layer.

THE OBSERVATORY OF PARIS.—M. Lœwy's report for the year 1904 is far too lengthy to be reviewed as a whole in these columns, but one or two of the more important details may be mentioned. In his introduction, the director mentions the progress made during the year in the Eros campaign, and also indicates how the photographs of the moon, taken for the large atlas he is preparing, afford evidence that the moon, and, inferentially, the planets, solidified from the surface towards the centre.

M. Bigourdan has temporarily arrested his observations of nebulæ with the equatorial of the east tower in order that the dome and instrument may be prepared for the determination of the absolute constant of aberration by M. Lœwy's new method.

A study of the garden meridian circle showed that a difference of 0''·45 existed between the readings of the two circles. Various possible causes for this discrepancy were examined, and finally it was discovered that the method of illuminating the microscope wires was at fault. The microscopes have been replaced by others, and the difference thereby eliminated.

The astrophysical department is awaiting the arrival of apparatus before making celestial observations, but in the meantime M. Hamy has carried out several laboratory researches, the chief of which related to the constancy of wave-lengths in the solar spectrum. He found that when the temperature of cadmium vapour in a vacuum tube was raised about 15° C., in the neighbourhood of 300° C., the line at λ 508 diminished several units of the order of $1\ \mu \times 10^{-6}$, and he suggests that the variation of temperature in the solar atmosphere may produce similar results.

During 1904, 80 catalogue and 31 *carte* plates were obtained in connection with the *carte du ciel* operations, whilst 67 plates containing 16,656 star-images were measured.

AN ELECTRIC MICROMETER.[1]

THERE is no finality in experimental measurement. In physics it is a common experience for a present-day worker, with better appliances and a wider horizon than his forerunners, to surpass all previous experimental work in accuracy. As knowledge increases it becomes more minutely exact, and nowadays the physicist has often to measure lengths much less than anything visible in any microscope.

There are various means of measuring small distances. We will take them in order, commencing with the least sensitive:—(1) The unaided eye cannot perceive much less than 1/10 millimetre. (2) With the aid of the microscope the eye can see as little as 1/5000 millimetre. (3) The measuring machine used for engineering gauges will detect differences of 1/8000 millimetre. (4) By using interference bands of light we can perceive movements of 1/100,000 millimetre. (5) In the optical lever a beam of light falls on a pivoted mirror; if a body push the mirror at a point very near the axis of the pivot the beam of light is deflected by a large angle. By this means a movement of the body by 1/400,000 millimetre may be detected. (6) The most modern and sensitive method, the electric micrometer, is due to Dr. P. E. Shaw, who produced it in 1900, and has improved it until he can now measure less than 1/2,000,000 millimetre. The nucleus of the apparatus is shown in the figure. A fine screw M has a graduated head N. The screw in rising pushes up the long arm of a lever pivoted at B. The short arm of the lever falls, and in so doing lets down the long arm of a second lever. This process is carried on through six levers, which all rest under their own weight on the blocks shown. The last lever carries a measuring point P, just above which is a measuring surface Q. If the joint leverage of the lever system be 2000/1, an upward movement of the screw point M by 1/1000 millimetre produces an upward movement of P by 1/2,000,000 millimetre.

As a simple example, suppose we wish to find the thermal coefficient of expansion of the rod R, we proceed thus:—Bring P and Q into contact. The screw M is worked up, while a telephone (Tel.), in the electric circuit shown, is on the observer's head. When P touches Q a circuit is completed, and the telephone sounds. Read the graduated disc N. Now lower the temperature of R by any desired amount, taking care that little or no heat reaches the pillars F' or any part but R. R contracts, and by working screw M up the observer causes P to touch Q again; the telephone sounds, and N is again read. The expansibility can thus be found, when we know the movement of P and the change in temperature.

The screw, the levers, and the frame F' are all carried by a massive girder I. The whole is surrounded by a box thickly wrapped in felt to minimise temperature changes, and is suspended by long rubber cords from the ceiling, to insulate the measuring apparatus from vibration.

The screw M is not touched by hand, but is worked by a pulley cord of rubber which passes from a hand pulley round pulley O. This is done to avoid the comparatively rough touch and tremor of the hand. There are many precautions as to shape, size, cleanliness, and other matters which must be observed.

[1] Based upon a paper by Dr. P. E. Shaw read before the Royal Society.

The smallest measurements ever yet made, viz. 1/2,000,000 millimetre, were in connection with the movements of a telephone diaphragm. The problem was to find what movement of the diaphragm produces a sound which is only just audible.

This is done as follows:—Place a telephone to the ear and pass through it a steady current. On stopping the current a sharp sound is heard in the telephone. Alter the strength of the current until when it is stopped the sound can only just be heard. Observe on a galvanometer the strength of that current (c). Next put the telephone in the electric micrometer in place of the rod R, pass the current (c), and measure the movement of the diaphragm in the usual way. This movement then produces a sound in the telephone which is just audible.

Another use of the instrument is to measure the sparking distance between two surfaces, the potential difference of which is known. The surfaces used are P, Q in the figure. Suppose the potential difference between these surfaces is very small, say 1/1000 volt. Find the contact position as above, and draw P away from Q. Now make the potential difference between P and Q equal to 1 volt. On making P approach Q the contact position has changed by an amount D. Thus the sparking distance for 1 volt is D (supposing the spark distance for 1/1000 volt is negligible). This is found to be about 1/100,000 mm.

In problems on the constitution and molecular properties of matter there are obvious possibilities before this apparatus, for by it we can bring two surfaces of any hard metal to molecular distance (or less) from one another, and keep them there while any desired physical change is produced in the surfaces or in the medium surrounding them.

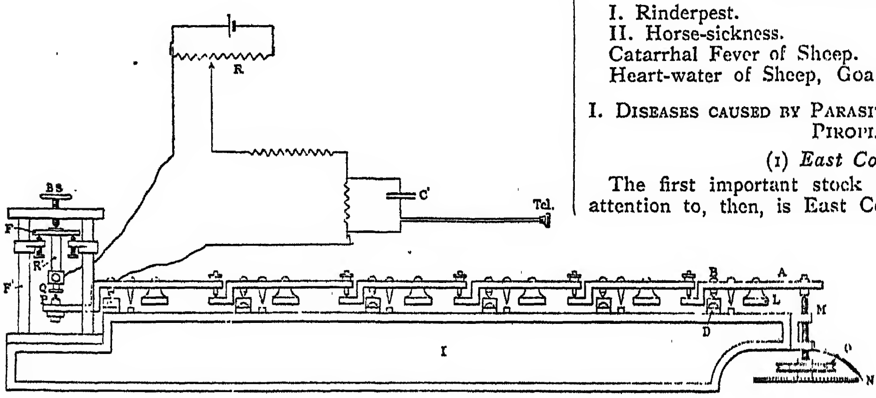

FIG. 1.—The Electric Micrometer.

THE BRITISH ASSOCIATION.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY COLONEL D. BRUCE, M.B., F.R.S., C.B., PRESIDENT OF THE SECTION.

The Advance in our Knowledge of the Causation and Methods of Prevention of Stock Diseases in South Africa during the last ten years.

TEN years ago, when I first came to South Africa, I was led to take an interest in the various great stock diseases which do so much damage and so retard the progress of South Africa as a stock-raising country. I thought, therefore, that a good subject for my address, in the centre of the foremost stock-raising Colony of South Africa, would be a review of the work done in advancing our knowledge, during the last ten years, of the causation and methods of prevention of stock diseases in South Africa. South Africa is particularly rich in animal diseases, every species of domestic animal seemingly having one or more specially adapted for its destruction. Now it is evident that, in an address of this kind, it will be impossible to take up every stock disease, but I think you will agree with me that those shown on this table are among the most important:—

East Coast Fever; ordinary Redwater or Texas Fever; Biliary Fever of Horses; Malignant Jaundice of Dogs; Nagana or Tsetse-fly Disease; Trypanosomiasis of Cattle; Rinderpest; Horse-sickness; Catarrhal Fever in Sheep; Heart-water of Sheep, Goats, and Cattle.

Now we may group these diseases in various ways; for example, as below, where they are divided into two main divisions: *A* division, in which the parasite is known; and *B* division, in which the parasite is unknown.

A. Parasite known.

I. Diseases caused by parasites belonging to the genus Piroplasma:—

(1) East Coast Fever (Koch), *P. parvum*.
(2) Redwater or Texas Fever, *P. bigeminum* (Theiler).
(3) Biliary Fever of Horses, Mules, and Donkeys, *P. equi*.
(4) Malignant Jaundice of Dogs, *P. canis*.

II. Diseases caused by parasites belonging to the genus Trypanosoma:—

(1) Nagana or Tsetse-fly Disease, *T. brucei* (Bradford and Plimmer).
(2) Trypanosomiasis of Cattle, *T. theileri* (Bruce).

B. Parasite unknown.

I. Rinderpest.
II. Horse-sickness.
Catarrhal Fever of Sheep.
Heart-water of Sheep, Goats and Cattle.

I. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS PIROPLASMA.

(1) East Coast Fever.

The first important stock disease I would direct your attention to, then, is East Coast Fever. This name was given to it by Prof. Robert Koch, of Berlin. In the Transvaal the disease is usually called Rhodesian Redwater. This term is not a good one, since the disease is not restricted to Rhodesia, nor did it arise there, nor is this a disease similar to the ordinary Redwater. Ten years ago, East Coast Fever was unknown in the Transvaal. The first known outbreak occurred only some three and a half years ago, when it broke out at Koomati and Neilspruit, in the Barberton district, and in the east of the Colony. The disease had broken out some time previously in Rhodesia, and the outbreaks in both Colonies were due to infection from Portuguese territory. Although this disease has only been introduced to the country during the last few years, it has already produced an enormous amount of damage among stock, and is probably the most dangerous disease that the people of the Transvaal have to cope with at the present time, and for some years to come.

In the Annual Report of the Transvaal Department of Agriculture there is a most excellent report by Mr. Stockman, the then Principal Veterinary Surgeon, on the work of the veterinary division for the year 1903–1904. A large part of this report is given up to East Coast Fever, and I must here express my indebtedness to Mr. Stockman for much of the following account of this disease. In the same Annual Report there is also an account by Dr. Theiler, the Veterinary Bacteriologist, of the experimental work. Messrs. Stockman and Theiler evidently worked together, and I must congratulate them on the immense amount of good, useful work done by them, and I would also congratulate the Government on having had the services of two such accomplished and energetic gentlemen during the late troublesome times. Unfortunately for the Transvaal, Mr. Stockman has accepted the post of Veterinary Adviser to the Board of Agriculture in England,

but I have no doubt his successor, Mr. Gray, from Rhodesia, will continue the good work begun by him.

East Coast Fever was first studied by Prof. Koch at Dar-el-Salaam, in German East Africa, and he at first mistook it for ordinary Redwater. It seems to occur as an endemic disease along a great part of the East Coast of Africa, but appears to be restricted to a narrow belt along this coast-line. The cattle inhabiting this region have become immune to the disease, and are, therefore, not affected by it. Cattle passing through the Coast district to the interior, or brought to the Coast district from the interior, are apt to take the disease and die. It was by the importation of cattle, therefore, which had passed through the dangerous Coast district that the disease was introduced into Rhodesia and into the Transvaal. On this map which I throw on the screen I have marked out the probable endemic area of this disease, and in the next slide the present distribution of the disease in the Transvaal is also marked out.

Nature of the Disease.—This disease only attacks cattle, but in them is an exceedingly fatal malady: in every hundred cattle attacked only about five recover from the disease. The duration of the disease after the first symptoms have occurred is about ten days.

The cause of the disease is a minute blood parasite called the *Piroplasma parvum* (Theiler). This parasite lives in the interior of the red blood corpuscles.

I now throw on the screen a representation of the blood from a case of Rhodesian Redwater, magnified about a thousand times, showing these small piroplasmata in the interior of the red blood corpuscles. As in the case of so many of these blood diseases, the parasite causing it is carried from the sick to the healthy by means of a blood-sucking parasite. In this particular disease the tick which most commonly transfers the poison or living parasite from one animal to another is known as the "brown tick," *Rhipicephalus appendiculatus*. Koch supposed that the common "blue tick" was the agent. The credit belongs to Dr. Lounsbury and Dr. Theiler of having shown that it is chiefly the "brown tick" which acts as carrier; but Theiler has proved that *R. simus* is also able to transmit the disease. Without the intervention of a tick, so far as we know at present, it is quite impossible that the parasite of this disease can be transferred from one animal to another. For example, if we take a quantity of blood containing enormous numbers of these piroplasmata, and inject it into the blood circulation of a healthy animal, the latter does not take the disease. In the same way, if cattle affected by East Coast Fever are placed among healthy cattle in a part of the country where none of these "brown ticks" are found, the disease does not spread. It is evident, therefore, that some metamorphosis of the parasite must take place in the interior of the tick, and this new form of the parasite is introduced by the tick into a healthy animal, and so produces the disease. In this particular disease the virus or infective agent is not transmitted through the egg of the tick, as is the case in some of these parasitic diseases, but only in the intermediate stages of the tick's development; that is to say, the larva which emerges from the egg of the tick is incapable of giving the disease. What happens is this. The larva creeps on to an infected animal and sucks some of its blood. It then drops off, lies among the roots of the grass, and passes through its first moult. The nympha, which is the name given to the creature after its first moult, is capable of transferring the disease to a healthy animal: that is to say, if it crawls on to a healthy animal and sucks blood from it, it at the same time infects this healthy animal with the germ of E.C.F. In the same way, if a nympha sucks infected blood from a sick animal, it is able, after it has moulted into the adult stage or imago, again to give rise to the disease if placed, or if it crawls, upon a healthy animal.

The Life-history of the Brown Tick.—I throw on the screen a slide representing the four stages of the life-history of the brown tick: The egg, the larva, the nympha, and the adult or imago. The eggs are laid on the surface of the ground by the adult females, which deposit several thousands at a time; and these hatch out naturally, if the weather is warm and damp, in twenty-eight days. But this period of incubation of the eggs may vary very greatly owing to differences in temperature. Immediately after the larva is born it crawls to the summit of a blade of grass or grass stem, and there awaits the passage of some animal. If an ox passes by and grazes on the grass, the tick at once crawls on to the animal, and, having secured a favourable position, starts to suck the ox's blood. It remains on the ox for some three or more days, when, having filled itself with blood, it drops off and lies among the grass. The first moult, under favourable conditions, takes twenty-one days, when the nympha emerges. In the same way the nympha crawls on to an animal and fills itself with blood. As a nympha it also remains on the animal for about three or four days. It again drops off into the grass, and at the end of eighteen days emerges from its second moult as the perfect adult male or female. The males and females again crawl on to an ox, where they mate. After this the female tick ingests a large quantity of blood, which is meant for the nourishment of the eggs, and again drops off, sometimes as early as the fourth day, into the surrounding grass. After about six days she lays her eggs in the ground, and the cycle begins again.

These ticks are very hardy, and in the intermediate stages can resist starvation for long periods, so that a larva or nympha or adult tick may remain perched at the end of a blade of grass for some months without finding an opportunity of transferring itself to a suitable animal. On this account it comes about that even if all infected cattle are removed from a field the ticks in that field will remain capable of transferring the infection to any healthy cattle which may be allowed into this field for a period of about a year. At the end of a year or fifteen months, however, the infective ticks are all dead, and clean cattle may be allowed into the field without any risk. If one takes these facts into consideration it will be seen that a single ox may spread this disease for a distance of some 200 miles, if trekking through the country at the average rate of ten miles a day. For example, an ox is infected by a tick; for fourteen days the animal remains apparently perfectly well; it has no signs of disease, nor has it any fever. It is capable of doing its ten miles' trek a day. At the end of fourteen days the temperature begins to rise, and the animal begins to sicken with the disease, but for the next six days the ox is, as a rule, able to do its ordinary day's march. During most of this time the brown ticks have been crawling on to this ox, becoming infected, and dropping off every three or four days. It can readily, therefore, be seen how much mischief a single infected animal can do to a country between the time of its being infected by the tick and its death some twenty-four days later. As a matter of experience, however, the disease has never been found to make a jump in this way of more than fifty or sixty miles, as, of course, it is very rare that a transport carrier will take his oxen more than that distance during the twenty days.

At the present time it may be said that there are about 500 infected farms in the Transvaal. During last year some 15,000 cattle have died of the disease, and in the affected districts it may be said that there are still some 30,000 cattle alive. When one considers the value of the cattle dead of this disease, which may be said to be about 200,000*l.*, it is evident that money spent on the scientific investigation of the causes and prevention of stock diseases is money well spent. I am informed that all the South African Governments are cutting down their estimates this year, and are inclined to reduce their veterinary staffs and the amounts devoted to research regarding animal diseases. Ladies and gentlemen, if this is so, I have no hesitation in saying that this is the maddest sort of economy and the shortest-sighted of policies.

Methods of combating the Disease.—During the last three years an immense amount of work has been done in the elucidation of this disease—how the animals are infected, how the poison is spread from the sick to the healthy, and so on. In 1903 Prof. Koch was asked by the South African Colonies to study this disease, in order to try to find some method of artificial inoculation or some other means of prevention. He did his work in Rhodesia, and especially directed his energies towards discovering some method of preventive inoculation. At first it was thought that he would be successful in this quest,

as in his second report he announced that he had succeeded in producing a modified form of the disease by direct inoculation with the blood of sick and recovered animals. As you are all aware, the only method of conferring a useful immunity upon an animal is to make it pass through an attack of the disease itself, so modified as not to give rise to above a few deaths in every hundred inoculated. This is the method that has been employed in such diseases as Rinderpest, Anthrax, Pleuro-pneumonia, and many other diseases. The great difficulty in this disease in finding a method of preventive inoculation is the fact that the blood of an affected animal does not give rise to the disease in a healthy one when directly transferred under the skin of the latter. It is only after its passage through the body of the tick that the parasite is able to give rise to the disease in a healthy animal. It is evidently, on the face of it, difficult to so modify the parasite during its sojourn in the tick's body as to reduce its virulence to a sufficient degree.

Prof. Koch in his third and fourth reports recommended that cattle should be immunised by weekly or fortnightly inoculations of blood from recovered animals, extending over a period of five months. Even though this method of Koch had given the desired result, viz. that it rendered the inoculated cattle immune to the disease, it is evident that the method itself can hardly be made a practicable one on a large scale in the field. The expense and trouble of inoculating cattle on twenty different occasions would be very great. It is apparent now that Prof. Koch fell into error through mixing up East Coast Fever with ordinary Redwater. His plan of preventive inoculation was, however, tried on a large scale in Rhodesia by Mr. Gray, now the P.V.S., Transvaal, and found to be useless. At present, therefore, we must look to some other means of preventing the disease and driving it out of the country than preventive inoculation.

Dipping.—Much can be done to prevent the spread of this disease by ordinary methods. For example: in the case of Texas Fever in Queensland dipping cattle in solutions of arsenic or paraffin, in order to destroy the ticks, has met with very fair success; but in the case of this disease we cannot expect to get as good results as in the case of Redwater. The species of tick which conveys Texas Fever remains on the same animal through all its moults, instead of falling to the ground between each different one. If it is not possible to spray or dip cattle oftener than once in ten or fifteen days, it is evident that ticks may crawl upon such animals, become infected, and drop off every three or four days, and so escape destruction by the dipping solution. At the same time every infected tick that is killed by spraying or dipping operations is a source of infection destroyed.

Fencing of Farms.—Again, the fencing of farms must also be useful in the same direction. As the ticks do not travel to any extent when they fall among the grass, it is evident that the cattle on a clean farm which is properly fenced will not become infected by this disease, although all the country round about should be infected. This fencing of farms and subdividing the farm itself into several portions is a most important factor in the prevention of contagious diseases amongst stock. It is, of course, impossible that this can be done at once, as the expense would be prohibitive.

Moving Cattle from Infected Pasture to Clean Pasture.—From a study of this disease and a study of the life-history of the tick it is evident that by a combination of dipping or spraying the cattle so as to destroy almost all the ticks, slaughtering the sick, and moving the apparently healthy on to clean veld—and repeating this, if necessary, a second or third time—it is obvious that by these means, if circumstances are favourable, an outbreak of this disease may be nipped in the bud without much loss to the stock.

Stamping out the Disease.—In May, 1904, an inter-Colonial Conference held at Cape Town resolved that the only effective method of eradicating East Coast Fever is to kill off all the cattle in the infected areas, and to leave such areas free of cattle for some eighteen months. By this means all the centres of infection would be destroyed, and at the end of eighteen months, as all the infected ticks would be dead, it is evident that the disease would be completely stamped out. There is no doubt that this drastic method would be the quickest and most complete one of getting rid of this extremely harassing disease. If compensation were given, it could be done at a cost of, say, a quarter of a million. The Government decided, however, that on account of the difficulty of carrying out such a drastic scheme another policy had to be considered. This policy provides for the fencing-in of infected farms, places, lands, or roads, on generous terms; the compulsory slaughter of stock with compensation in the case of isolated outbreaks; the removal of all oxen from infected or suspected farms; and, lastly, the stabling of milch cows in infected areas. It is quite evident that under this less drastic policy the final stamping-out of the disease will be a much slower process than if the more drastic scheme of compulsory slaughter of all cattle on infected areas had been carried out. The benefits, however, from the modified scheme are undoubted; and if carried out thoroughly and intelligently for a period of several years will probably result in the stamping-out of the disease.

Allow me to sum up in regard to the advance in our knowledge of this important stock disease during the last ten years. Ten years ago nothing was known. Now the causation of the disease has been made out very fully; the parasite that causes it is known; the ticks which carry the infection are known. Although no method of conferring immunity on healthy cattle has been found out, or any medicinal treatment discovered which will cure the sick animal, yet our knowledge of the life-history of the parasite and the ticks enables regulations to be framed which, if patiently carried out, must be crowned with success.

(2) *Redwater or Texas Fever.*

I may dismiss this disease in a few words. It is a most interesting disease and of great importance to stock farmers. It only affects cattle.

Geographical Distribution.—It is a disease found in almost every part of the world. It was first studied in North America; hence the name Texas Fever. To Kilborne and Smith is due the honour of elucidating the causation of this disease, and their work forms one of the most interesting chapters in the history of pathological science. They discovered that it was caused by the presence in the red blood corpuscles of a protozoal parasite closely related to the parasite found in E.C.F.—the *Piroplasma parvum*. This organism is called *Piroplasma bigeminum*. They further discovered that this parasite was conveyed from sick to healthy cattle by means of a tick. They also showed that the cattle born and bred in certain southern districts are immune to the disease, whereas cattle in the northern districts are susceptible. Hence, if southern cattle were driven into the northern district, they gave rise to a fatal disease among the northern cattle; and, *vice versâ*, if the susceptible northern cattle were driven into the southern district among the apparently healthy cattle of that district, they took Texas Fever and died.

Texas Fever was introduced about 1870, and is now endemic throughout most of South Africa. For many years the native cattle have been immune to the disease; that is to say, on account of being born and bred in a Texas Fever locality they had inherited a degree of resistance to the disease which enabled them to pass through an attack when they were young, and so they became immune. But there is one peculiarity about Texas Fever which does not occur in Rhodesian Tick Fever, and that is that the blood of an animal which has recovered from Texas Fever remains infective—the germs remain latent—and so the native cattle of South Africa, although apparently healthy, are capable of infecting imported susceptible cattle with this very fatal malady. This is what makes it so difficult to import prize stock into this country.

When the Boers visited Mooi River, at the beginning of the war, they found a prize short-horn carefully stabled in Mr. P. D. Simmon's farm. They killed most of his stock for food, but left this short-horn bull alive. When they left the farm they turned this bull into the nearest field, in order, of course, that it might procure food. They had much better have eaten it. It promptly took Texas Fever and died.

This disease, then, has become of secondary importance

to South Africa in these days. The native cattle have become naturally immune, and the disease is only fatal to susceptible imported cattle. This, of course, discourages the importation of prize stock; but with the knowledge we possess it ought to be possible, by good stabling and prevention of contact with tick-infected cattle, to keep the prize stock alive for a reasonable time. The question of the feasibility of immunising the prize stock while calves in England might be considered.

In regard to methods of conferring immunity on susceptible cattle many have been tried, but none are absolutely free from risk.

We may sum up in regard to Redwater or Texas Fever by saying that our knowledge of its causation and methods of prevention is much the same as it was ten years ago. The work done by Smith and Kilborne on this disease was of such a brilliant nature, and was done so thoroughly, that little has been left for later workers to do.

(3) *Biliary Fever of Horses, Mules, and Donkeys.*

This is a disease of horses, mules and donkeys very similar to Redwater in cattle, and is caused by a closely allied parasite, the *Piroplasma equi*, discovered for the first time in South Africa by Bordet, Danysz, and Theiler, and named by Laveran of Paris.

It is similar to Redwater, in that animals which have recovered from the disease remain a source of infection during the remainder of their lives to susceptible animals. The native South African horse is, like the cattle, immune to the disease. It is also conveyed by a tick, which has been shown by Theiler to be the "red tick" (*Rhipicephalus evertsi*), the infection being taken in the nymphal and transferred in the adult stage. Theiler has also made the very important observation that if a horse is injected with blood from a donkey which has recovered from the disease, as a rule a mild form of the disease is produced, so that this opens up a method of immunising susceptible horses which may probably prove of practical value. Theiler has also made another curious discovery. This disease of horses was found to greatly complicate certain immunising experiments he was making against Horse-sickness. He found he was introducing the *Piroplasma equi* at the same time he injected Horse-sickness virus. But he found out that as the virus of Horse-sickness keeps its virulence for years, whilst the *Piroplasma equi* dies out in a short time, this danger could be avoided by keeping the Horse-sickness serum and virus for some time before using it.

(4) *Malignant Jaundice of Dogs.*

This disease is most important to sportsmen or to importers of valuable dogs, as most of these are attacked sooner or later by this disease, and most of them succumb. It is also caused by a species of Piroplasma (*Piroplasma canis*), and is spread by the dog tick (*Haemophysalis leachii*).

Like Redwater and Biliary Fever, the blood of dogs which have recovered remains infective.

The story of the tick infection is a curious one, and the credit of its discovery is due to Lounsbury. It is only in the adult stage that the tick is capable of producing the disease. It is therefore evident that the Piroplasma must remain latent in the egg, the larval and nymphal stages, and only attain activity in the adult stage.

According to Theiler there exists a peculiar phenomenon which may be made use of to confer immunity. The blood of a dog which has recovered from this disease and has been hyper-immunised is, as mentioned above, capable of giving rise to the disease in a susceptible dog. Now, if serum be obtained from this blood and a quantity added to a small amount of the blood, this infected blood loses its infectivity and no disease results.

II. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS TRYPANOSOMA.

(1) *Nagana or Tsetse-fly Disease.*

We now come to the second group of diseases. These are also caused by blood parasites belonging to the same class of living things as the Piroplasma, but which are free organisms, swimming in the fluid part of the blood, and not contained in the red blood corpuscles, as are the others.

The first of this group I would direct your attention to is that disease called *Nagana* or the *Tsetse-fly Disease*.

This fly renders thousands of square miles of Africa uninhabitable. No horses, cattle, or dogs can venture, even for a day, into the so-called "Fly Country." Now what was our knowledge of this disease ten years ago? At that time it was thought that the tsetse-fly killed animals by injecting a poison into them, in the same way as a snake kills its prey. Nothing was known as to the nature of this poison in 1894. In 1895, on account of serious losses among the native cattle in Zululand from this plague, the then Governor of Natal and Zululand, Sir Walter Hely-Hutchinson, started the investigation of this disease. The result of this investigation was the discovery that Tsetse-fly Disease was not caused by a simple poison elaborated by the fly, as formerly believed, but that the cause of the disease was a minute blood parasite which gained entrance to the blood of the animals. This parasite is known by the name Trypanosoma, which signifies a screw-like body.

Ten years ago two species only had attracted much attention—one living in the blood of healthy rats, discovered by Surgeon-Major Lewis in India; and the other, a trypanosome, found in the blood of horses and mules suffering from a disease known in India as "Surra." As the result of this investigation in Zululand, which lasted two years, it was proved that this trypanosome was undoubtedly the cause of the death of the horses and cattle struck by the fly, and that the tsetse-fly merely acted as a carrier of this blood parasite.

Here is a representation of the trypanosome of Nagana on the screen. These trypanosomes consist of a single cell; are sinuous, worm-like creatures, provided with a macronucleus and a micronucleus, a long terminal flagellum, and a narrow fin-like membrane continuous with the flagellum and running the whole length of the body. When alive they are extremely rapid in their movements, constantly dashing about, and lashing the red blood corpuscles into motion with their flagellum. They swim equally well with either extremity in front. These organisms multiply in the blood by simple longitudinal division, and often become so numerous as to number several millions in every drop of blood. They are sucked, along with the blood, into the stomach of the fly, live and multiply in the alimentary tract for several days, and, when the fly has its next feed on an animal, take the opportunity of gaining access to the blood of the new host, and so set up the disease.

Let me now throw on the screen a representation of the tsetse-fly (*Glossina morsitans*) which does all the mischief. Experiments were made which showed that the fly could convey the parasite from affected to healthy animals for at least forty-eight hours. It is a curious fact that among all the blood-sucking flies the tsetse-fly alone has this power, and up to the present the cause of this has not been thoroughly cleared up. Lately, however, evidence has been brought forward to show that an enormous multiplication and development of the trypanosomes take place in the fly's intestine, a few trypanosomes multiplying to masses containing numberless parasites within twenty-four hours. Now, if this multiplication only takes place in the intestine of the tsetse-fly, and not in the other kinds of biting flies, this would probably account for the curious connection between the tsetse-fly and the disease. This multiplication of the trypanosomes in the tsetse-fly was discovered by Gray and Tulloch, two young army medical officers, while working in Uganda on "Sleeping Sickness" during the present year.

Not only was it found that the tsetse-flies could convey the disease from sick to healthy animals, but it was also proved that the wild tsetse-flies brought from the "Fly Country" and straightway placed on healthy animals also gave rise to the disease. The question then arose as to where the tsetse-flies living in the "Fly Country" came by the trypanosomes. There were no sick horses or cattle in the "Fly Country." Investigation brought to light the curious fact that most of the wild animals—the buffalo, the koodoo, the wildebeeste—carried the trypanosomes in small numbers in their blood, and it was from them that the fly obtained the parasite. The wild animals act as a reservoir of the disease. The trypanosome seems to live in the blood of the wild animals without doing them any

harm, just as the rat trypanosome lives in the blood of healthy rats; but when introduced into the blood of such domestic animals as the horse, the dog, or ox it gives rise to a rapidly fatal disease. The discovery that the wild animals act as a reservoir of the disease accounted for the curious fact that Tsetse-fly Disease disappears from a tract of country as soon as the wild animals are killed off or driven away.

In 1895 the living trypanosome which causes the Tsetse-fly Disease was sent to England in the blood of living dogs, in order that it might be studied in the English laboratories. These trypanosomes have been kept alive ever since by passage from animal to animal, and have been sent all over Europe and America, so that our knowledge of this kind of blood parasite has rapidly grown.

Koch, in a recent address, says that our knowledge of protozoal diseases is based on three great discoveries—that of the malarial parasite, by Laveran; of the *Piroplasma bigeminum*, the cause of Texas Fever or Redwater in cattle, by Smith; and, lastly, this discovery of a trypanosome in Tsetse-fly Disease.

We may, therefore, I think, congratulate ourselves on the growth of our knowledge of this great stock disease during the last ten years.

Since 1895 many other trypanosome diseases have been discovered in all parts of the world. The latest and most important of these is one which affects human beings, and is known as "Sleeping Sickness." This "Sleeping Sickness," which occurs on the West Coast of Africa, particularly in the basin of the Congo, has within the last few years spread eastward into Uganda, has already swept off some hundreds of thousands of victims, is spreading down the Nile, has spread all round the shores of Lake Victoria, and is still spreading southward round Lakes Albert and Albert Edward. This disease is in all respects similar to the Nagana or Tsetse-fly Disease of South Africa, except that it is caused by another species of trypanosome and carried from the sick to the healthy by means of another species of tsetse-fly—viz. the *Glossina palpalis*.

I now throw on the screen a map of Africa, showing, so far as is known up to the present, the various fly districts, and you will see from this map that it is not at all improbable that this human Tsetse-fly Disease may spread southward through the various fly districts to the Zambesi, and may even penetrate as far as the fly districts of the Transvaal and Zululand.

I am sorry to say that, in spite of innumerable experiments directed towards the discovery of some method of vaccination or inoculation against these trypanosome diseases, nothing definite, up to the present time, has been discovered. At present there does not seem to be any likelihood that a serum can be prepared which will render animals immune to the Tsetse-fly Disease. In the same way it has also been found impossible, up to the present, to so modify the virulence of the trypanosome as to give rise to a modified, non-fatal form of the disease. Again, all attempts at discovering a medicine or drug which will have the power of killing off the parasites within the animal organism, without at the same time killing the animal itself, have not as yet been successful, although some drugs, such as arsenic and certain aniline dyes (Ehrlich), have a very marked effect in prolonging the life of the animal. As this disease is fatal to almost every domestic animal it attacks, it seems very improbable that there is much chance of cultivating an immune race of horses, dogs, or cattle which will be able to withstand the action of the parasite. It is quite evident that if an acquired immunity of this kind could be brought about, such a race of immune animals would now be found; but, as a matter of fact, there are no horses, dogs, or cattle in the "Fly Country." In other protozoal diseases, such as the Piroplasmata, this acquired immunity seems to come about fairly readily.

To sum up, then, the increase in our knowledge of Tsetse-fly Disease during the last ten years, we may say that we have discovered the cause in the shape of the small blood parasite Trypanosoma; we have found that the reservoir of the disease exists in the wild animals, and that we can blot out this disease from any particular tract of country by the simple expedient of destroying or driving away the wild animals. We still have no means of preventive inoculation or successful medicinal treatment in this disease.

(2) *Trypanosomiasis of Cattle.*

This disease seems to be widespread over all South Africa. It cannot be said to be of much practical importance, as the cattle infected do not seem to be seriously affected by it. It is caused by a species of trypanosome remarkable for its large size, which was discovered by Dr. Theiler some years ago, and named *T. theileri.*

Dr. Theiler states that it is conveyed from animal to animal by the common horse-fly, *Hippabosca rufipes.*

This, then, is a short account of the trypanosome diseases which affect South Africa.

Of late years the Tsetse-fly Disease has become of less practical importance to the Transvaal, from which it has practically disappeared. This is due to the disappearance of the game, killed off by Rinderpest; but with the preservation and restoration of the reserves with big game the disease is certain to reappear. Why the fly should disappear with the game is not known.

B. Parasite unknown.

I. *Rinderpest.*

We now turn our attention to the important diseases of the second group. In these the parasites causing them are unknown—that is to say, no parasites can be detected by the microscope or by culture—but it is equally true that they must be present in the blood and fluids of the sick animals in some form or other. In all probability they are ultra-microscopic—too small to be seen with our present instruments. This is borne out by the fact that they are able to pass through the pores of porcelain filters, which keep back the smallest micro-organisms we are able to recognise.

The first of the second group of diseases is Rinderpest, which has overrun and devastated South Africa within the last ten years.

Rinderpest has been known from time immemorial in Europe and Central Asia, and is an exceedingly fatal disease, killing 90 to 100 per cent. of the cattle attacked.

The recent epidemic, according to some, originated in the Nile provinces, and slowly crept southwards, reaching the Transvaal in 1896, after a journey lasting some fifteen years. Great efforts were made to oppose its passage, but nothing seemed to avail. In parts of the country where there were few or no cattle the epidemic spread by means of the wild animals—particularly the buffalo—which have been exterminated in many places.

Ten years ago the symptoms and contagious nature of this disease were well known, but nothing was known as to methods of prevention, and it is to the investigation of this epidemic in South Africa that the discovery of practical methods of immunising cattle, and in this way of stamping out the disease, is due.

As soon as it was apparent that the epidemic was spreading into South Africa, all the Colonies made strenuous efforts to combat it. The Transvaal Government invoked the aid of the Pasteur Institute, and Messrs. Bordet and Danysz were sent out to discover some method of prevention. They worked near Pretoria, and were assisted by Dr. Theiler, then the Principal Veterinary Surgeon. Before they arrived on the scene the Natal Government had dispatched Mr. Watkins-Pitchford, their Principal Veterinary Surgeon, to the Transvaal, where he also at first had Dr. Theiler as his colleague, and where he did some good pioneer work in the serum therapeutics of the disease. In the Cape Colony Dr. Hutcheon, the Principal Veterinary Surgeon, and Dr. Edington, the Government bacteriologist, were no less active. It is, however, to Prof. Robert Koch, of Berlin, that the honour is undoubtedly due of first publishing a practical method of immunising cattle against Rinderpest. He arrived at Kimberley on December 5, 1896, and in the incredibly short space of time of two months was able to report two methods of immunising, viz. by the injection of Rinderpest bile, and, secondly, by the injection of serum from immune animals. I have always thought that the discovery that the injection of bile taken from an animal dead of Rinderpest rendered cattle immune was particularly

brilliant. Up to that time no one had dreamt that bile could possess such a quality. It is true that both Transvaal and Orange Free State Boers are said to have used a mixture of bile and blood from dead animals before Koch's researches, and also that Semmer in 1893 showed that serum might be used for protective purposes; but still to Koch is due the credit of making these processes practical. After he left South Africa his work was continued by Kolle and Turner, who greatly improved the methods; and it is to them, and to the other workers mentioned above, that we owe the fact that Rinderpest has now lost its terrors.

In the last recrudescence of this disease in the Transvaal, in 1904, Mr. Stewart Stockman, the Principal Veterinary Surgeon, and Dr. Theiler, thanks to the experience and knowledge gained during the last ten years, were enabled to stamp out the disease rapidly and completely. It is to them also that we owe our knowledge of the dangers of the intensive method of inoculation, much used in the past and due to Kolle and Turner, and the introduction of the fighting against the plague by the inoculation of the healthy cattle by injections of immune serum alone.

In the Tsetse-fly Disease our advance in knowledge has been in regard to the causation of the disease, and not in its prevention; it is quite otherwise with Rinderpest. The contagion or cause of Rinderpest is absolutely unknown. We know it exists in the blood, nasal, mucous, and other secretions of the sick animal, as all these are infective, but no one has seen it. The smallest quantity of blood will give the disease if injected under the skin of a healthy animal. We also know that the contagium is not very resistant. Blood soon loses its virulence after it leaves the body, and the effect of drying or the addition of chemical preservatives, such as glycerin, act also injuriously to the contagium, whatever it may be. It evidently belongs to the ultra-visible sort of micro-organisms, as it is said to pass through a porcelain filter.

How the contagium passes from the sick to the healthy is assumed to be by contact. No experiments have, so far as I am aware, been made as to whether it is conveyed by insects as well; but, as Prof. John MacFadyean says, as it spreads in all countries and climates and seasons, and the contagium is easily carried on the persons or clothes of human beings, it is improbable that insects have anything to do with it.

It is in the methods of protective inoculation that the great advance has been made in our knowledge of this disease. Ten years ago no means were available to stay the progress of this plague; now it has lost its terrors. As soon as it appears it can be immediately attacked and stamped out. This is done by rendering the surrounding cattle immune to the disease by injecting immune serum. This serum is prepared by taking immune cattle and hyper-immunising them by the injection of large quantities of virulent blood, so as to make their blood serum as anti-toxic as possible. If there are no immune cattle at hand, cattle can be immunised by Koch's bile injection method and then hyper-immunised; but, of course, in practice—for example, here in the Transvaal—large quantities of immune serum are kept ready for emergencies, and a herd of immune cattle kept up for the supply of the serum. This satisfactory state of affairs, so far as this disease is concerned, is, of course, the outcome of an immense amount of thought and experiment, and I have already mentioned the chief scientific men to whom this country owes this great boon.

Different methods of immunising have been tried during these years. Up to 1903 the prevailing custom was to use what was known as the virulent-blood and serum method. That is to say, immune serum and virulent blood were injected at the same time, in order that the animal might pass through a modified attack of the disease. Since 1903, however, in the Transvaal this method has been stopped, and the "serum alone" method introduced. This method is based on the fact that the virus of Rinderpest does not retain its infective property outside the body for more than a day or two; that it dies out in the animal, as a rule, in fourteen days, but in chronic cases only after thirty days, and that therefore the healthy cattle in an affected herd must be protected for this length of time. Now "serum alone" only protects for about ten days, and therefore the cattle must be inoculated three times at intervals of ten days. The doses of serum must also be large—from 50 c.c. to 200 c.c.—so that this method of stamping out Rinderpest, although quite efficacious, entails a good deal of labour. It is necessary, then, to spare no expense in making the Veterinary Department efficient, and any cheese-paring legislation in this direction may be disastrous.

II. *Horse-sickness.*

The next stock plague I would bring before your notice is Horse-sickness. This is a disease which only affects equines—the horse, mule, and rarely the donkey. It is a very fatal disease, carrying off thousands of horses every year. It is one of the most important diseases in South Africa, and, if it could be coped with, would enable the Transvaal to become one of the best horse-breeding countries in the world. At present it is dangerous for anyone in Natal and many parts of the Transvaal to possess a valuable horse, the chances of losing it by Horse-sickness being so great.

In 1895, when I went to the north of Zululand with the Ingwavuma Expedition, we lost all our horses with this disease. We started with a hundred horses, and had to march back on foot, every horse having died.

Ten years ago, when I arrived in South Africa, our knowledge of this disease was confined to the disease itself; nothing was known as to its causation or prevention. Credit is due to Dr. Edington for having accurately described the lesions and shown its ready inoculability, period of incubation, &c. He, however, fell into the mistake of attributing its causation to a species of mould fungus.

Etiology: Geographical Distribution.—Horse-sickness is widely distributed throughout Africa. It is common in Natal, Zululand, the greater part of the Transvaal, Rhodesia, Bechuanaland, and Portuguese East Africa. In Cape Colony it occurs in epidemics, with intervals of ten to twenty years. It is undoubtedly a disease which prevails chiefly *in low-lying localities* and valleys, and is but rarely met with in elevated exposed positions. It, however, is met with now and then in river valleys up to an elevation of some thousands of feet. *Season* has also a remarkable influence on its development, being exceedingly common in summer and disappearing on the appearance of the first frosts of winter.

Ten years ago various theories were held as to the cause of this disease. Some people thought that it was due to eating poisonous herbs; others, to some peculiarity or state of the night atmosphere; others, to eating grass covered with dew; and still others, to the eating of the spiders' webs which may be seen on the grass in the morning. It was known at that time not to be contagious in the ordinary sense of that term; that is to say, a horse could be stabled alongside a case of Horse-sickness without incurring the disease, or a horse might be placed without danger in the same stall in which a horse had recently died of Horse-sickness.

Nature of the Disease.—A horse which has been exposed to infection shows no signs of the disease for about a week. Its temperature then goes up rapidly, and it dies after four or five days' illness. Very often the horse appears perfectly well until within a few hours of death. For example, my horse was the last one to die on the Ingwavuma Expedition. On the day of his death I rode him until noon without noticing anything amiss. He then became rather dull in his movements, and I handed him over to the groom to lead. He died that evening immediately after we got into camp. It is, therefore, a very rapidly fatal disease, and almost every horse which is attacked by it succumbs. I have never seen a case of Horse-sickness which had been brought on by artificial inoculation recover. But there can be no doubt that a small percentage of horses infected naturally do recover, and these recovered horses are, more or less, immune in future to the disease. There is no necessity for me to describe the symptoms of this well-known disease, as everyone who has to do with horses in South Africa is perfectly familiar with it, and everyone has seen dead horses with the characteristic mass of white foam issuing

from their nostrils, due to the effusion of the liquid part of the blood into the lungs and trachea.

Nature of the Virus which causes this Disease.—There can be no doubt that this disease, like the Tsetse-fly Disease, is caused by some form of blood parasite. A small quantity of fluid taken from any part of a horse suffering from Horse-sickness is capable of giving rise to the disease if injected under the skin of a healthy horse. For example: the thousandth part of a drop of blood from a sick horse will, in many cases, give rise to the disease if injected under the skin of a healthy horse. It must be admitted, however, that some horses require a larger dose than others, but it may be said that no horse has yet been found to withstand more than a comparatively small quantity of infective blood thrown under the skin. Now, although every drop of blood must contain many of the organisms of this disease, yet the most careful examination of such blood under the highest powers of the microscope reveals nothing. Again, if we filter Horse-sickness blood through a porcelain filter—a filter which is capable of keeping back all the known visible micro-organisms—the filtrate is found to be virulent. It is evident, then, that we are here dealing with a blood parasite so small in size as to be absolutely invisible to the highest powers of the microscope, and also so minute as to readily pass through the pores of a Chamberland filter. What the nature of this parasite is one cannot tell. It behaves in many curious ways. For example, Horse-sickness blood which is simply dried and pounded into powder is found to be perfectly inert. On the other hand, blood kept in the moist condition remains virulent and capable of giving rise to the disease for years. Or, again, the germ of Horse-sickness is so resistant to external agencies that if, as described by MacFadyean, a part of the liver of a horse dead from Horse-sickness be buried in the ground and subjected to putrefaction, it is found that the liver tissue retains its infectivity for months. Although a very small quantity of blood introduced under the skin of a horse will almost certainly give rise to the disease, it is quite different if the blood is introduced into the stomach. In the latter case a small quantity of blood has no effect, and the horse requires to be drenched with a pint or more before the disease can be given in this way.

The question now arises as to how horses are infected by this disease in Nature. On account of the small quantity of blood which will give rise to the disease if injected under the skin, and the large quantity required before the disease can be conveyed through the stomach, for a long time it has been supposed that it must be conveyed from sick to healthy horses by means of some biting insect. Experiments have been made within the last few years by Watkins-Pitchford and others in order to clear up this aspect of the question. Horses have been placed in fly-proof shelters in exceedingly unhealthy places, and it was found that in no case did any of these protected horses incur the disease; whereas horses allowed to feed in the same place, but without any shelter, soon succumbed to the disease. But, up to the present, so far as I am aware, the particular biting fly, mosquito, or other insect which is the carrier of this disease has not been discovered, and there can be no doubt that one of the most important facts to make out in the etiology of this disease is the discovery of the particular insect which conveys the disease from the sick to the healthy. By this discovery a flood of light may be thrown on the causation of the disease, and some means discovered of combating the disease through the insect, as has been successful in some instances in regard to the case of human malaria.

Prof. MacFadyean also suggests that experiments are needed to show what is the "reservoir" of the virus.

Prevention.—Although we have been unfortunate up to the present in not being able to make out the exact nature of the parasitic cause of this disease, or to discover the exact insect which carries it, a large amount of patient persevering work has been done within the last ten years in regard to its prevention by protective inoculation.

In this important work Bordet, Edington, Koch, Theiler, Watkins-Pitchford, and others have laboured for many years, and, according to recent reports, with some measure of success.

Dr. Edington, for example, who has been working at this problem for several years, reports that Heart-water is identical with Horse-sickness, and that by inoculating mules with Heart-water blood he has been able to salt them against Horse-sickness. He says that experiments testing this vaccine show it to be an ideal one. It gives a high protection to the animals inoculated. Its keeping powers are excellent. No animal has died as the result of this inoculation nor has any dangerous symptom been produced. He states that he is not in a position to supply a vaccine for Horse-sickness in horses, but has every hope of attaining this successful end very shortly.

We must congratulate Dr. Edington on his results, and trust that this method of conferring immunity may prove itself to be successful when put to practical use. For my part, I am somewhat sceptical of Dr. Edington's methods of immunising against Horse-sickness. I am sure he will forgive my expression of scepticism when I recall to his memory the various methods he has already brought forward, just as optimistically, which have all been tried and found wanting.

Dr. Koch has lately recommended a method of immunisation against Horse-sickness. This is the artificial establishment of an active immunity in susceptible animals by gradually increased doses of virulent blood, alternated in the early stages of treatment with the injection of serum prepared from the blood of highly fortified salted horses. Mr. Gray reports that the experiments already conducted on these lines show that the process as laid down by Koch requires important modification before the process of establishing immunity against Horse-sickness can be of any practical use.

Mr. Watkins-Pitchford in Natal is also hopeful of succeeding in producing immunity against Horse-sickness.

Dr. Theiler, too, reports that he has succeeded in producing a serum which can be utilised in connection with virulent blood to confer active immunity. He informs me that his method is a subcutaneous injection of serum and an intra-jugular injection of virus carried out simultaneously. The death rate in mules, from the effect of the inoculation, he states to be about 5 per cent. It is higher in horses, but he expects shortly to attain the same result in them. During the last Horse-sickness season he exposed 200 immunised mules to natural infection in various parts of the country. Of that number only one died with symptoms of Horse-sickness. As Dr. Theiler is himself communicating his method in detail to the Association, I need not enter more fully into it.

The man who discovers a practical method of dealing with Horse-sickness will be one of the greatest benefactors of this country. There has always been a tradition that a large money reward is awaiting this discovery. I do not know whether this is well founded or not, but certainly such a work would well deserve the highest possible reward. The best reward is to give the successful investigator more opportunity and more assistance in pursuing his beneficent work. The reward given by the French people to Pasteur was the Pasteur Institute; by the German Government to Koch, the Imperial Hygienic Institution.

Catarrhal Fever of Sheep: Blue Tongue.

This disease was first described by Hutcheon, the Chief Veterinary Surgeon of Cape Colony.[1] It is very similar in many respects to Horse-sickness. Both these diseases occur most often in low-lying, damp situations, such as river valleys and the coast plain. They also occur at the same time of the year; that is, from January to April. Blue Tongue, like Horse-sickness, is probably carried from the sick to the healthy by means of some night-feeding insect. At the same time the diseases are not identical, since the inoculation of Horse-sickness blood into a sheep does not give rise to Blue Tongue, nor the blood of the sheep injected into the horse give rise to Horse-sickness.

To Mr. Spreuill, Government Veterinary Surgeon in

[1] It is to Mr. Hutcheon that South Africa owes its knowledge of many stock diseases. For the last twenty-five years he has laboured with the utmost earnestness in Cape Colony, often under trying conditions, and his description of the various diseases formed the basis of all the modern work done on the subject.

Cape Colony, acting under the advice of Hutcheon, is due the credit of proving that a preventive serum could be prepared capable of immunising sheep against this disease. Dr. Theiler informs me he has repeated Mr. Spreuill's experiments, and they hope to introduce this method of inoculation at an early date.

Heart-water of Cattle, Goats, and Sheep.

This disease was also first clearly described by Mr. Hutcheon. It occurs in the Transvaal, Natal, and Cape Colony, and is responsible for much of the yearly loss among the cattle, sheep, and goats.

Like the last disease—Blue Tongue—it resembles Horse-sickness in many ways, and, in fact, has been described by Dr. Edington as being identical with it. Like Horse-sickness, it is a blood disease with an invisible parasite, so that blood injected under the skin of susceptible animals gives rise to the disease. One difference between the parasites of the two diseases is, that whereas that of Horse-sickness is contained in the fluid of the blood, that of Heart-water is probably restricted to the red blood corpuscles. The serum separated from the blood is incapable of giving rise to the disease, and the straw-coloured pericardial fluid, when injected into susceptible animals, fails to give rise to any symptoms of the disease. Horse-sickness blood filtered through a porcelain filter is still infective; the opposite holds good up to the present with Heart-water. Horse-sickness blood can be kept for years without losing its virulence; Heart-water blood loses it in forty-eight hours.

Heart-water has a peculiar distribution, being restricted to the certain tracts of country with a warm, moist climate. It is known to farmers that if they remove their flocks to the high veld the disease dies out.

To Lounsbury is due the credit of explaining these facts. He found that the disease is carried from sick to healthy animals by means of the bont tick, *Amblyomma hebraeum.* This tick leaves its host between each moulting, and a larva which sucks the blood of an infected animal is capable of giving rise to the disease in a susceptible animal either as a nympha or imago. The distribution of this tick corresponds to the distribution of the disease. If this tick could be killed off, the disease would disappear from the country. This could doubtless be done on individual farms by long-continued dipping; but in the meantime some method of immunisation might be devised.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE next session at the South-Eastern Agricultural College, Wye, will commence on Monday, October 2, when an address will be given by Prof. Marshall Ward, F.R.S.

THE new session of King's College will be opened on October 3, when an address will be delivered by Prof. Clifford Allbutt, F.R.S., on "Medical Education in London." On October 4 an inaugural lecture will be given by Prof. Arthur Dendy on "The Study of Zoology."

THE inquiry into the general conditions of the home life of the Berlin brass-workers, their education and trade conditions, which the small party of Birmingham delegates carried out last April, is embodied in an interesting and entertaining manner in a report recently issued—"The Brass-workers of Berlin and of Birmingham," by Messrs. R. H. Best, W. J. Davies, and C. Perks (P. S. King and Son, price 1s.). The sensible inferences and criticisms contained in the report are ample evidences of close and accurate observation. The net practical conclusion of the inquiry seems to be that so long as the Birmingham brass-worker confines himself to the reproduction of a number of plain models, his work, especially his polished brass-work, is excellent, both in price and in finish; but "the Berlin training schools have produced a class of artisans with artistic talent, who find ready employment and are of great assistance to the employers. . . . A proper apprenticeship to his trade has fitted him (the Berlin brass-worker) and placed him in a position to supply the internal construction of intricate work without every minute detail being put down for him on paper. In the bronzing and treatment of the finish a greater freedom is apparent and a greater variety and novelty"; in fact, "they lead the way, we follow. . . ." The moral is obvious; indeed, in the further discussion of this point we find what is undoubtedly the most generally applicable and valuable criticism in the whole report:—"It is on the intellectual side that Birmingham requires to adapt itself to changed conditions: not to cheapening its wares but to getting more conception into them."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 13.—"The Amplitude of the Minimum Audible Impulsive Sound." By Dr. P. E. **Shaw.**

In a previous paper (*Phil. Mag.*, December, 1900) the author found this quantity by direct measurement, and Rayleigh, Franke, Toepler, and Boltzmann have investigated the minimum audible for continuous sound. In each of the above researches the micrometer was not sensitive enough actually to measure the least audible amplitude; the relation of current to amplitude was determined for relatively large amplitudes, and separate measurements were made of the current which gives the least audible sound. Extrapolation then gives the amplitude in question.

The present paper shows how the amplitude can be measured directly without extrapolation; it is even possible, as shown in the tables, to measure movements the amplitude of which is too small to be audible. The instrument is the improved electric micrometer described at the Royal Society (see p. 495), which is capable of showing a movement of 0·4 $\mu\mu$.

There are two distinct parts in the determination:—

(1) Observe the position of the diaphragm of a telephone when at rest, by making electric contact; draw away the measuring point of the micrometer and pass a steady current through the telephone so as to move the diaphragm to a new position of rest. Now move up the measuring point to the diaphragm, watching the micrometer screw and listening to the contact. Thus measure the movement of the diaphragm due to a set of steady currents down to such small ones as cause imperceptible motion. Plot the relation between movement and current.

(2) Apply the ear to the telephone and pass through it the same set of currents as before. For each current, except the smallest, a sound is heard when the current is stopped. We thus learn the relation of current to audibility.

The curve above at once gives the relation of amplitude to audibility. The sound is impulsive, for the diaphragm is released from a position of strain, vibrates under great damping, and soon comes to rest.

Both right and left ear of the author were used. He found, averaging results, 0·7 $\mu\mu$ as result for the right ear, and 0·9 $\mu\mu$ for the left.

The fundamental of the diaphragm when clamped hard to the case was found by testing it against tuning forks to have frequency about 580.

The following table of amplitudes is given:—

	A	B
Just audible	0·7 $\mu\mu$	0·14 $\mu\mu$
Just comfortably loud	50 $\mu\mu$	10 $\mu\mu$
Just uncomfortably loud .	1000 $\mu\mu$	200 $\mu\mu$
Just overpowering ...	5000 $\mu\mu$	1000 $\mu\mu$

The word "just" here implies in each case the lower limit. The amplitude of the diaphragm must not be confused with that of the air which it vibrates. Lord Rayleigh obtained the relation between these amplitudes to be roughly 5 to 1.

Column A gives numbers actually found in the telephone, and using Rayleigh's factor we obtain column B for the corresponding amplitude of the air.

It should be observed that 0·14 $\mu\mu$ is the smallest audible amplitude for an expectant ear when the conditions as to silence are exceptionally favourable; yet 10 $\mu\mu$ is the amplitude for the smallest audible sound in air, about which the ear can be quite sure when the conditions are normally favourable, and the ear not listening for the sound.

From the results found the author calculates the ampli-

tudes near the source of various great sounds, *e.g.* thunder, cannon firing, and volcanic explosions. He gives reasons for supposing that in rough terms these are not more than 1/12 mm., 1/4 mm., 1/200 mm. respectively. The volcanic sounds are carried to very great distances; but the sound source is very large in extent, and the amplitude at the source therefore may not be very great.

June 16.—"The Absorption Spectrum and Fluorescence of Mercury Vapour." By W. N. **Hartley**, F.R.S.

The author having undertaken the investigation of the absorption spectra of metals in a state of vapour, the first substance examined was mercury. It was volatilised in a flask of Heraeus's quartz glass, with a side tube to the neck from which the metal may be distilled and condensed. The rays from a condensed spark were passed through the flask and on to a cylindrical condensing lens of quartz which focused the rays on to the slit of a quartz spectrograph.

The Absorption Spectrum.—The whole rays were transmitted from the red to a point in the ultra-violet where there is a tin line at λ 2571·67. From there to λ 2526·8 there is a very sharply defined and intense absorption band, somewhat degraded on the side towards the red, beyond that the rays are transmitted with full intensity to a wavelength about 2000.

The Fluorescence.—When the mercury was boiling briskly the whole side of the flask nearest to the spark was lighted up with a green fluorescence; this penetrated about one-third of the space within the flask, and lighted up the interior. The quartz glass itself was not fluorescent in the slightest degree. Solutions of mercuric chloride showed no absorption band.

The absorption band in the vapour of mercury belongs to the vapour, and is accompanied by strong fluorescence between a certain maximum and minimum of temperature lying very near to the boiling point. It is a question still undecided whether the rays absorbed by mercury vapour, as shown by the band measured, reappear with a lowered refrangibility as yellowish-green light in accordance with the law of Stokes.

NEW SOUTH WALES.

Royal Society, June 7.—Mr. H. A. Lenehan, president, in the chair.—On the so-called gold-coated teeth in sheep: Prof. A. **Liversidge.** Paragraphs in some of the London and Sydney newspapers have stated that gold-coated teeth have been found in Australian sheep. The author recently received the lower half of a sheep's jawbone from Dubbo, the teeth of which are more or less completely incrusted with a yellow metallic substance, but more like iron pyrites (marcassite) or brass than gold. The deposit is about 1/32 of an inch, or less than 1 mm. in thickness. Under a half-inch objective it is seen to be made up of thin translucent layers, but there is no recognisable organic structure. The metallic lustre is due to the way in which the light is reflected from the surface of the superimposed films. The scale partly dissolves in dilute acids. The residue consists of filmy organic matter, still possessing a metallic sheen, although white in colour instead of yellow. The chemical examination shows that the incrustation on the teeth is merely a tartar-like deposit, made up principally of calcium phosphate and organic matter.

July 1.—Mr. H. A. Lenehan, president, in the chair.—Observations on the illustrations of the Banks and Solander plants: J. H. **Maiden.**

PARIS.

Academy of Sciences, September 4.—M. Troost in the chair.—Researches on the insoluble alkaline substances formed by humic substances of organic origin, and their *rôle* in plant physiology and in agriculture: M. **Berthelot.** The experiments were made with fresh and old specimens of humic acid prepared from sugar, with dead leaves, and with soil. The substances extracted by maceration with water and by distillation with water in presence of potassium and calcium salts were analysed.—The eclipse of the sun of August 30 observed at Paris: M. **Lœwy.** In spite of the interference caused by cloud, the partial eclipse was observed at Paris under good conditions. The times of first and second contacts were obtained, and numerous photographs were taken.—Actinometric measurements carried out during the eclipse of August 30: J. **Violle.** The observations at Trappes, Bordeaux, and on the Pic du Midi were spoilt by the weather, but satisfactory results, details of which will be communicated later, were obtained at Bagnères and Sfax.—On the existence in certain gooseberry trees of a compound furnishing hydrocyanic acid: L. **Guignard.** In the case of the common red gooseberry, hydrocyanic acid has been obtained from the leaves at all stages of their growth, but is absent from the fruit. The leaves of several other species have been examined for prussic acid with negative results.—On the glycuronic acid of the blood: R. **Lépine** and M. **Boulud.**—The secretary read telegrams from various observers relating to the solar eclipse of August 30, from which it would appear that satisfactory observations were obtained at Alcasebre, Sfax, Guelma, and Philippeville, clouds interfering at Cistierna, Burgos, Tortosa, and Alcalá de Chisbert.—Observation of the eclipse of August 30 at Alcalá de Chisbert (Spain): Marcel **Moye.** The brilliant corona was the most marked feature of the eclipse.—On the same: R. **Mailhat.** Remarks on some photographs taken at Paris.—On the envelopes of spheres of which the two sheets correspond with conservation of the angles: A. **Demoulin.**—On the importance of the effect of irradiation in spectrophotography: Adrien **Guébhard.**—The constitution of the copper aluminium alloys: Léon **Guillet.**—On the origin of lactose. The effects of injection of glucose into females during lactation: Ch. **Porcher.**—The geology of the southern Carpathians: G. M. **Murgoci.**—The influence of the solar eclipse of August 30 on the earth's magnetic field at Paris: Th. **Moureaux.** The oscillations observed during the eclipse were much greater than the regular diurnal variations.—On the polarisation of the sky during the eclipse of the sun: M. **Piltschikoff.**

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THURSDAY, SEPTEMBER 21, 1905.

THE EVOLUTION OF MATTER.

L'Evolution de La Matière. By Dr. Gustave Le Bon. Pp. 389. (Paris: Flammarion, 1905.) Price 3.50 francs.

DR. GUSTAVE LE BON has written many books. Some twenty volumes, besides papers in current scientific periodical literature, have issued from his pen. History, travels, tobacco-smoke, anthropology, horsemanship, and psychology have in turn attracted his sympathetic interest.

The work before us sets forth Dr. Le Bon's theories of matter and energy, and contains, in a small-print appendix, an abstract of the experimental evidence on which he is content to rest those theories.

According to the author, matter itself is merely a form of energy—probably vortex energy in the luminiferous æther. Matter disintegrates—spontaneously in radio-active substances, but also under the influence of certain agencies such as heat or chemical action, which are compared with the spark that fires a barrel of gunpowder. After giving rise to "les produits de la dématérialisation de la matière: ions, électrons, rayons cathodiques, &c.," all things finally pass into "l'élément immatériel de l'univers: l'Éther." By the dissociation of matter, energy is transformed, and "c'est de l'énergie intra-atomique libérée par la dématérialisation de la matière que dérivent la plupart des forces de l'univers."

The chief experimental evidence on which Dr. Le Bon relies may be grouped under two heads:—(1) the emission of negatively electrified particles by metals when incandescent and when subjected to the action of ultra-violet light; (2) the slight radio-activity which may be detected in ordinary materials.

The emission of negative corpuscles from metals under the influence of heat and light undoubtedly occurs, though it is not to the author's speculative opinions that we owe the experimental demonstration of the fact. As a speculative hypothesis, the idea that the corpuscles are emitted during the disintegration of the atoms of the metal is perhaps worth bearing in mind. But, on a review of the evidence known at present, it seems unlikely that the removal of these slow-moving negative corpuscles results in the instability of the atom from which they are derived. There is no evidence that an electric discharge through a gas produces new elements, while the ions of liquids and gases, which result from the removal of the corpuscle, again yield the original atom when neutralised. Such processes are to be distinguished sharply from the irreversible changes which occur in true radio-activity, when bodies of atomic mass (α rays) or fast-moving corpuscles (β rays) are projected. In this case, new chemical substances always appear, and the process seems to be unaffected by heat, light, or any other physical or chemical agency. This essential distinction is not noticed by Dr. Le Bon, who assumes that the production of a corpuscle is itself a proof of atomic disintegration.

The author claims that he was the first to show that radio-activity is a universal phenomenon, not confined to a few substances:—

"Mon premier mémoire sur la radio-activité de tous les corps sous l'action de la lumière a paru dans la *Revue Scientifique* de mai 1897. Celui sur la radio-activité par les actions chimiques a été publié en avril 1900. Celui montrant la radio-activité spontanée des corps ordinaires a paru—toujours dans la même revue—en novembre 1902. Les premières expériences par lesquelles les physiciens aient cherché à prouver que la radio-activité pouvait s'observer avec des corps autres que l'uranium, le thorium et le radium n'ont été publiées par Strutt, McLennan, Burton, &c., que de juin à août 1903."

We may first notice that Dr. Le Bon classes the effects of light under the head of radio-activity. This, it may be argued, is a matter of definition, and the author is at liberty to give a meaning to the word radio-activity different from that adopted by all other physicists. But it is well to point out that many experiments on the electric effects of the incidence of light on metals had been made before the year 1897, notably by Elster and Geitel between 1889 and 1895. Dr. Le Bon may have been the first to suggest that the effects were due to the emission of particles, but no conclusive evidence was obtained until the experiments of J. J. Thomson and Lenard, in 1899, had determined the ratio of the charge to the mass, and identified the particles with those found in kathode rays.

Secondly, doubt has been thrown on the emission of rays by substances undergoing chemical action by the recent experiments of Mr. N. R. Campbell, who has traced some, at all events, of the effects to secondary causes connected with the heat of reaction. Here Dr. Le Bon does not seem always to separate clearly the ionisation which may be produced in a gas by contact with substances undergoing chemical change, and the emission of radiations, more or less penetrating, characteristic of true radio-activity.

Thirdly, in examining the spontaneous radio-activity of ordinary materials, the author seems to underestimate the effect of the minute traces of radium which are now known to be distributed widely. He claims Prof. J. J. Thomson's experiments on the emanations emitted by various natural substances and underground waters as a confirmation of his view that all matter is radio-active. Now, Thomson found that the rate of decay and the phenomena of excited activity in those emanations which he examined closely were about the same as those of the radium emanation, and his experiments should be regarded as an indication of the prevalence of radium rather than of the radio-activity of ordinary materials. It is true that further experiments by Thomson, Cooke, Campbell, Wood, and others have now made it probable that ordinary metals, at all events, are slightly radio-active. But, to eliminate the effects of strongly radio-active impurities, it is necessary to take the utmost precautions, both in the experiments themselves and still more in the interpretation of the results. There seems little evidence that, in either respect, Dr. Le Bon recognised the necessity of such precautions.

It will be gathered that the author takes a point of view which is not that of the majority of physicists who have investigated these subjects. Revolutionary opinions may prove a valuable tonic to the orthodox in physics as in other matters. It is not because he is heterodox that we are not satisfied by Dr. Le Bon's book. It is because he seems to us to fail in grasp of the subject, to confuse phenomena which are essentially different, and to be blind to evidence which does not support his hypotheses.

A belief in the evolution of matter is fast becoming not only possible but inevitable. Dr. Le Bon has written readable speculations about that evolution, and here and there has thrown out an interesting idea; but the evidence on which that belief must be founded is not that put forward by him. His book calls to mind the advice offered by a famous Lord Chief Justice to a brother judge, that it was sometimes safer to give one's conclusions without the reasons which had led to them.

W. C. D. W.

THE FÆRÖES AND ICELAND.

The Faeröes and Iceland; Studies in Island Life. By N. Annandale. With an appendix on the Celtic Pony by F. H. Marshall. Pp. vi+238; illustrated. (Oxford: Clarendon Press, 1905.) Price 4*s*. 6*d*. net.

THE name of Mr. Nelson Annandale has been of late years so intimately associated with the Malay Peninsula and its zoology and ethnology that it comes somewhat as a surprise to find it on the title-page of a work dealing with such totally different surroundings as those of the Færöes and Iceland. It appears, however, that between the years 1896 and 1903 the author spent several summer holidays in these remote islands, and contributed a series of articles on his experiences to *Blackwood's Magazine* and the *Scotsman*, and that it is these delightful articles, in a more expanded and elaborated form, with the omission of certain purely technical details, which form the basis of the work before us.

As Mr. Annandale suggests in his opening chapter, most persons probably regard the Færöes as little more than mere Arctic rocks, teeming with sea-birds, in the ocean; and they will accordingly be surprised to learn that, as a matter of fact, although lying nearly a couple of hundred miles to the north-west of Shetland, they enjoy a climate warmer than that of many parts of Scotland, while their vegetation, if rarely more than a few inches high, is as luxuriant as the shallowness of the soil and the winter storms will allow. The buttercups, too, seem larger, and the bushes of a brighter green, than on the mainland. These islands have also to be regarded as desirable spots, for it appears that although a few years ago they possessed a couple of dozen policemen, the *moral* of the population has been so excellent that the services of these guardians of the peace were found no longer necessary, and the force has consequently been disbanded. A truly remarkable record!

The first two chapters deal with the people of the Færöes and their mode of life, and will be found to contain a number of interesting observations on their ethnography and the implements of the islanders. The invasion of Iceland by the Moors in the seventeenth century forms the subject of a third chapter, but perhaps the most interesting part of the whole book is that dealing with the wonderful bird-cliffs of the Westman Islands, and the clever manner in which the natives capture puffins and other birds in nets. The fulmar appears, indeed, to be very valuable to the Westmaners, supplying them with both food and light. Other chapters deal with Iceland and its products, and the insects and domesticated animals of both that island and the Færöes.

Mr. Annandale deserves, indeed, our most hearty congratulations, and has succeeded in producing a most admirable little work which may be perused with interest alike by the general reader and by those who have enjoyed, or expect to enjoy, the opportunity of visiting the islands he so happily describes. Whether similar congratulations should be extended to Dr. Marshall for his share of the work we are not fully assured. That gentleman seems, indeed, to be under the impression that no one save Profs. Ewart and Ridgeway has written in this country on the origin of the horse. Otherwise he would have scarcely credited the former with being the first to regard Przewalsky's horse as a variety of *Equus caballus*. Neither would he have omitted to notice that an earlier name than *przewalskyi* has been suggested as referable to this animal, and also that Prof. Ewart's *E. celticus* is probably inseparable from the earlier *E. hibernicus*. Moreover, he might have pointed out that it is difficult to understand how Prof. Ridgeway's new name of *E. c. libicus* can stand for the barb, when the Arab horse has long since received a technical name of its own.

R. L.

OUR BOOK SHELF.

Le Système des Poids, Mesures et Monnaies des Israélites d'après la Bible. By B. P. Moors. Pp. 62+1 plate of figures and 6 tables. (Paris: A. Hermann, 1904.)

THE first part of this work consists of an inquiry respecting the numerical value adopted by the Israelites at the time of Solomon for the constant π, the ratio of the circumference of a circle to its diameter. M. Moors obtains the greater part of his material for this investigation from the dimensions of the "molten sea" in Solomon's temple, as stated in I. Kings, vii., 23–26, and II. Chronicles, iv., 2–5. These dimensions have led some writers—notably Spinoza and Hoefer—to the opinion that the Israelites knew of no nearer approximation to π than the whole number 3. The specification of the molten sea is not, however, sufficiently complete to determine its shape with any degree of certainty. Some commentators have considered it as cylindrical, others have followed Josephus in ascribing to it a hemispherical form, whilst Zuckermann suggests a combination of cylinder and parallelepiped. The author of this work, who is firmly of opinion that the Israelites accepted a value for π very close to 3·142, has found it necessary in support of his argument to assume that the molten

sea had the form of a lipped cylinder. Adopting the description given in I. Kings, which differs somewhat from that of II. Chronicles, M. Moors has deduced for the cubic contents of the *bath*, a measure of capacity frequently met with in the Old Testament, the relation

$$1 \text{ bath} = \tfrac{1}{8} \text{ (Mosaic cubit)}^3.$$

The remainder of the work deals with the system of weights, measures, and coinage in use among the Israelites. Carefully disclaiming any bias in questions theological, he adopts the Bible as the chief authority on the subject of which he treats. The weights and measures mentioned in the Bible are not, however, always very clearly defined, and in attempting to combine them in a homogeneous system we are confronted with apparently hopeless inconsistencies. Owing to this difficulty M. Moors finds it necessary to have recourse to materials of somewhat incongruous character. From a strange medley of midwives, manna and mummies, he evolves, with much ingenuity, a series of metric equivalents for the weights and measures of the Israelites. He claims that his equivalents are confirmed by all those passages in the Bible which contain references to weights and measures. It is interesting to note that his value for the length of the cubit, viz. 443·61 millimetres, agrees very closely with the value obtained recently by Sir Charles Warren (17·64 inches, = 448·05 mm.).

It is hardly possible to accept the view of M. Moors that the Bible was intended *inter alia* as a text-book on mensuration. In spite of his laudable effort to throw light on the old Hebrew weights and measures they still remain dim to us. In the region of metrology the Israelites would indeed appear to have baffled the commentator, and to have buried their authoritative standards "deeper than did ever plummet sound" out of the excavator's reach.

So far as we have checked the numerical calculations made by M. Moors, we have found them invariably accurate. There is, however, an obvious misprint in the last line of his letterpress; "43·5" should read "43,500."

A Primer on Explosives. By Major A. Cooper-Key. Edited by Captain J. H. Thompson. Pp. xii+94. (London: Macmillan and Co., Ltd., 1905.) Price 1s.

THIS little book should prove of great value to those for whose benefit it has been mainly written, viz. the local inspectors under the Explosives Act, and those dealers whose trading necessitates the handling and storage of explosives.

No one can better realise the want of some little handbook on the subject than H.M. Inspectors, and it is to meet this want that Major Cooper-Key has written this useful book, which, it is pointed out, is "not a treatise on explosives." The author gives a short description of the manufacture of the chief explosives, but its great value will be found in the sections devoted to special risks with each class, the methods of packing and storing, and a particularly useful chapter on the general construction and management of a store, the destruction of explosives, &c.

It is certain that a careful study of the book by local inspectors will lead to a better understanding of the whole question of explosives and the Act generally, and hence to a more intelligent performance of their responsible duties. For those traders and users who have the handling of these goods after they have left the manufactory the book should be equally valuable, and it should do much to lessen the risk of those untoward accidents which occur from time to time, generally from ignorance of the properties of the bodies dealt with. J. S. S. B.

A Note-book of Experimental Mathematics. By C. Godfrey and G. M. Bell. Pp. 64. (London: Edward Arnold, 1905.) Price 2s.

THIS book gives concise instructions for carrying out a number of simple quantitative experiments in mechanics. It is specially suited for students who intend to sit for Army Entrance Examinations, but the excellence of the course outlined renders the book very serviceable for general use in schools; the students get accustomed to fundamental methods of measurement, obtain concrete conceptions of elementary science, and secure much data well adapted to serve as examples and illustrations in a course of practical mathematics. The experiments include measurements of lengths, areas, volumes, weights, specific gravities, fluid pressures, forces, moments, velocities, accelerations, and many other physical quantities. A full and careful list is given of the requisite apparatus and fittings, and the book will be of very great assistance to teachers in the arrangement of a thoroughly sound elementary course of experimental science.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Cause and Prevention of Dust from Automobiles.

THE article on the above subject in the issue of NATURE for September 14 (p. 485) is an important contribution to a subject of great interest and importance to the community, but it contains a statement with reference to tar-macadam which in the interests of engineers should, I think, be verified. Speaking of "Tarmac" the writer says, "the slag is thoroughly impregnated, so that if the pieces are broken further a tarred surface is still found."

I have examined many specimens of tar-macadam, including "Tarmac." I have never found any sign of penetration of tar. I am aware that some believe in this alleged penetration, but it seems to be obvious that any material sufficiently porous to enable tar to saturate it would be totally unfit for road-making.

That tar-macadam, and, of course, "Tarmac," have virtues for motor road-making may be admitted; but this penetration theory is not the reason, and it is a pity that the myth should still exist, as it tends to prevent the trial of other substances far more suitable for roads than furnace slag.

The reason why tarred granites and similar hard stones have not hitherto been found so effective is entirely a matter of surface adhesion. Given a suitable tar mixture, there is no reason why hard, non-porous stone should not be as efficient as slag. Penetration has nothing to do with it. J. VINCENT ELSDEN.

38 St. Stephen's Gardens, Twickenham.

IN reply to Mr. Elsden, I agree that it is of no use to hold mythical views. I think, however, that he is really mistaken in his views that the slag in "Tarmac" is not penetrated by the tar. Possibly it may not be penetrated by the most viscous constituents, but upon examining a broken piece of "Tarmac" I have found that the surface is distinctly darker than that of slag which has not been treated. The difference is very noticeable under the microscope, and if a bit of slag from the interior of a treated portion is heated the tar is readily seen, which fact appears to be conclusive evidence that penetration by the tar takes place. I do not, however, suppose that the penetration is very uniform, as slag is not a very uniform material, and therefore in some parts the effect might not be so evident. W. R. COOPER.

82 Victoria Street, S.W.

THE SOLAR PHYSICS OBSERVATORY ECLIPSE EXPEDITION.

Innsbruck, September 12.

SINCE my last letter, which was dated August 26, I have had so little time for writing that I take the first opportunity to record the events that followed the last communication. Passing over August 28 and 29, which were spent in giving the final touches to the various instruments, putting in the eclipse mirrors, and in rehearsing, we come to the eclipse day itself. Turning out at 5 a.m. and scanning the sky, a glance showed that clear weather conditions for eclipse time were very doubtful. Heavy black clouds were sailing majestically across the zenith, and still blacker ones were slowly moving nearer the horizon. There were, however, small breaks here and there where blue patches were exposed for brief intervals, but it seemed that the chances for a clear eclipse were very small.

FIG. 1.—The officers of H.M.S. *Venus* volunteering for eclipse work on the quarter-deck.

It was not long, however, before many of us reached our camp. Rain had fallen about 4 a.m., and at about 6 a.m. another shower helped still further to lay the dust, which had proved such a menace to the smooth working of the clocks. The previous evening all dark slides had been carefully filled and noted with their particular make of plates, and these now were distributed to the different workers.

Fortunately we were working in an area enclosed by a wall, so that only those who had received special permission could enter. Needless to say, invitations were numerous, and included the majority of those who had helped us in various directions during our preparations.

At the time of first contact, clouds near the region of the sun were very few, and we observed this under excellent conditions. As time progressed, a great bank of clouds was seen gradually working its way along from the west, and it became a race between the clouds and the moment of second contact, *i.e.* the beginning of totality. The diminishing crescent became smaller and smaller at about the same rate as the clouds over the sun became thicker and thicker. The clouds won! The moment of second contact could not be observed! We went, however, through our programmes, knowing that we were photographing nothing. Venus became a brilliant object in the west seen through a break.

6-inch prismatic camera. 16-feet coronagraph tent. The tent of Lieut. Horne (Commandant of Camp) and myself.

FIG. 2.—Visitors being shown round the camp on the day before the eclipse. Looking west.

Fortunately there were two currents of air at work in the upper regions, one coming from the south and the other from the west. This intermingling of currents was possibly the cause of the thinning of the clouds over the sun, and gave us a view of the corona for brief intervals through, as it were, a thin

veil; the clearest intervals were towards the end of totality. The burst of sunlight from the north-west limb of the sun heralded the end of totality, and thus ended the work of the instruments and the greater majority of the different parties.

We were all, however, bitterly disappointed. So much trouble had been taken to make everything work with the maximum of efficiency, but, alas! with so small a result. Prismatic cameras of high dispersive power and prismatic reflectors of long focal length, to say nothing of long-focus lenses for three-colour negatives, are not conducive to good results in a cloudy sky!

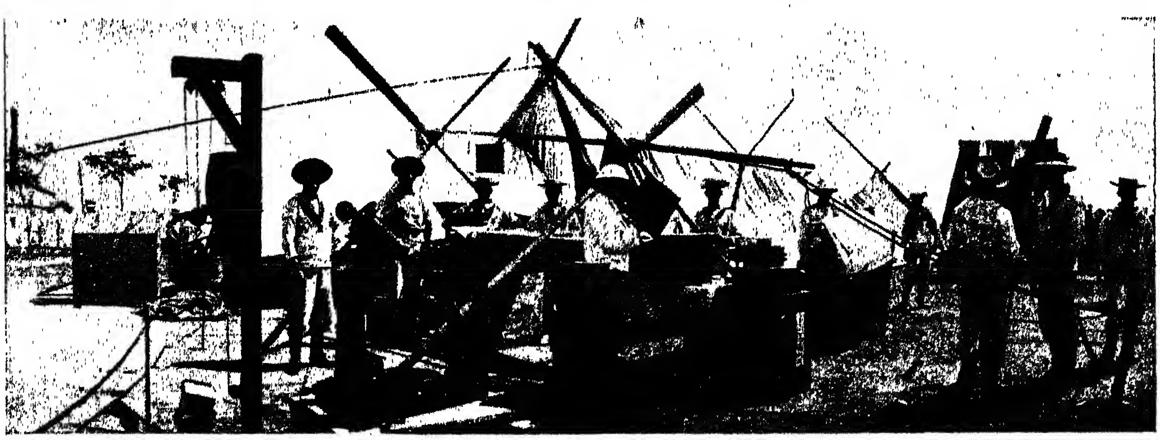
During the few moments that were available between the exposures of the different plates in my instrument I saw enough of the corona to know what a magnificent sight it would have been had it been seen in a cloudless sky. The enormously brilliant red prominence in the north-east quadrant was an undoubted feature of this eclipse, and nothing like it was seen by me in either the 1898 or 1900 eclipses. From several accounts the landscape was illuminated by this red radiating object, and sunset effects were recorded by other observers.

The corona itself was of the maximum type, streamers radiating in all directions even very near the poles. At the north pole there was a region displaying the beautiful rifts seen at best during eclipses at a minimum stage, but at the southern pole no such distinctive structure was seen. Unfortunately the eastern and western limb of the sun were shrouded in thicker haze than the north and south region at the time that I had my longest glance. It was therefore about the solar poles that the longest streamers were seen by me, and two in the south-east quadrant extended for at least two solar diameters.

Mr. F. McClean. De la Rue coronagraph behind the men. Grating spectrograph. Mr. Howard Payn.

Fig. 3.—Taken after the beginning of first contact. The tents over the instruments have all been removed. The 16-feet coronagraph, with Mr. F. McClean and his naval staff.

The eclipse being over there was then nothing more to do than to collect all the photographic plates exposed and commence with the packing up of the instruments. It is one thing to set up the instruments and another to take them down. By the evening of the same day about 50 per cent. of the packing up had been completed.



Siderostat. Tube of 6-inch prismatic camera. Packing cases supporting small cameras with gratings. Cusp telescope. Three-colour camera in distance.

Fig. 4.—The 6-inch prismatic camera, showing staff and positions for the small grating cameras and the cusp telescope.

In the cool (?) of the evening the development of the plates was commenced. Those which promised to have some kind of record on them were taken first. To sum up the results, now that the whole set has been developed, it may be said that we have been far more fortunate than was at first anticipated. The prismatic reflector worked by Mr. Butler succeeded in securing an excellent picture of the lower corona, the solar diameter being about 8½ inches. The 16-feet

coronagraph operated by Mr. F. McClean obtained a fine photograph of the corona with excessively sharp detail and good extension. The De la Rue coronagraph in charge of Lieut. Trench, R.N., was fortunate enough to secure three negatives, all of which will be very serviceable, as the focus was so well adjusted. Unfortunately the long exposures required for the three-colour camera operated by Lady Lockyer could not be secured in consequence of clouds. The $3\frac{1}{2}$-inch Newton, mounted equatorially and worked by Staff-Surgeon Clift, obtained two successful exposures. The instrument in my charge secured four negatives that will prove useful, one of which displays the green coronal ring clearer than those which were secured in the 1898 or 1900 eclipses, and several other distinct coronal rings in addition. The spectrum of the lower chromosphere at the beginning or end of totality was not obtained. The objective grating spectroscope worked by Mr. Howard Payn produced one out of two exposures made, and shows the spectrum of the larger prominences and the green coronal ring.

The observers of the shadow bands gained a great amount of information as regards their size, rate of motion, and direction. The coronal sketchers obtained very concordant results, and the other parties gleaned much useful information, which will be published later, as the observations have not yet been brought together.

FIG. 5.—The camp four hours after the eclipse, showing how quickly the instruments were removed.

By the evening of Sunday, September 3, the whole of the instruments, tents, dark room, and smaller huts were comfortably on board, and we steamed away to Palermo, leaving our camp as bare as we found it. Two copies of each negative had been made and separately packed to ensure loss against accident.

With the exception of Mr. Butler, who proceeded to Malta in H.M.S. *Venus*, and of Mr. Payn, who remained at Palma, our party bade farewell to the officers and men of H.M.S. *Venus* who had worked so hard, and whom Dame Nature had treated so badly. Crossing to Naples, where we left Mr. F. McClean, we took the train the same morning to Rome, and after a short rest and a little sight-seeing journeyed to Innsbruck, travelling through the beautiful Brenner Pass, to attend the meeting of the Solar Commission of the International Meteorological Committee. Perhaps by the time that the next eclipse occurs we may know a little more about "weather" to enable observers to go to regions where they will not be totally or even partially clouded out!

WILLIAM J. S. LOCKYER.

INTERNATIONAL METEOROLOGICAL CONFERENCE AT INNSBRUCK.

THIS International Meteorological Conference was opened at Innsbruck on September 9, when Dr. Hildebrandsson, the secretary of the International Meteorological Committee, read the report of the operations of that body on the part of M. Mascart (president) and himself, and explained that at the Southport meeting in September, 1903, Dr. Pernter's proposal that a conference of the directors of meteorological services should be held at Innsbruck this year, similar in character to those at Munich in 1891 and Paris in 1896, was favourably regarded and subsequently adopted.

The vacancies which have occurred on the committee from various causes have been filled by the appointment of Dr. Palazzo and Dr. Shaw in succession to Prof. Tacchini and Dr. Scott. Dr. Hildebrandsson was elected secretary on the retirement of Dr. Scott, who, since the creation of the committee, had performed this function with a zeal and devotion which would be most gratefully remembered. The following changes have also been made:—M. Chaves, director of the Meteorological Service of the Azores, was appointed in place of Admiral de Brito-Capello, Dr. Hellmann in succession to Prof. von Bezold, and M. Lancaster in succession to M. Snellen.

Sir John Eliot, having ceased to be director of the Indian Meteorological Service, tendered his resignation as a member of the committee, but, with the approval of the India Office, communicated through Dr. Shaw, the committee invited him to retain his seat, as representing in Europe the Meteorological Service of India. Thus the committee has the great advantage of counting among its members residing in Europe a man of experience and possessing a thorough knowledge of the meteorology of the tropics.

According to the report presented by M. Wild and Dr. Scott to the conference at Munich, and adopted

by it, the principal object of these private conferences of the directors of meteorological services was "the discussion of concrete questions, the arrangements of procedure as to methods of observation and calculation, and the organisation of common investigations." Since that period several investigations have been organised by the subcommittees nominated by the international committee.

The Munich conference nominated a committee for cloud observations, under the presidency of Dr. Hildebrandsson, whose duty it was to publish an international cloud atlas, and to organise and direct observations and measurements of clouds in different countries during a year. The cloud atlas was published in 1896 by MM. Hildebrandsson, Riggenbach, and Teisserenc de Bort. International cloud observations and measurements were made at a great number of stations from May 1, 1896, to the end of 1897, on a plan fixed by the committee at the meeting at Upsala in 1894. The publications, in accordance with instructions laid down by the subcommittee, have appeared, and the principal results have been published by Dr. Hildebrandsson in a report of which the first part was presented to the international committee at the Southport meeting, and the second part is now presented to the conference. The subcommittee has now completed its work.

At the Paris meeting, in 1896, other subcommittees of a similar character were nominated, *e.g.* an aëronautical committee, with Dr. Hergesell as president, for the purpose of organising international scientific aëronautical experiments, especially simultaneous balloon ascents at different stations. A committee was formed under the presidency of Sir Arthur Rücker for the purpose of international researches on terrestrial magnetism and atmospheric electricity.

These subcommittees have had several meetings, and have organised some important investigations. A third subcommittee was constituted at Paris in 1896 for the study of solar radiation. There have been no special meetings, but M. Violle has presented to each sitting of the international committee a report of the principal researches undertaken in different countries. At the St. Petersburg meeting, in 1899, the international committee appointed a telegraphic subcommittee, under the presidency of Dr. Pernter, with the view of suggesting possible improvements in telegrams for weather prediction. Lastly, at the request of Sir Norman Lockyer and Dr. Shaw, the committee appointed a subcommittee for the study of questions relating to simultaneous solar and terrestrial changes, under the presidency of Sir Norman Lockyer.

The reports of these subcommittees show that their labours have been of the greatest utility for the development of meteorological science. By this means it has been possible to organise and carry out successfully investigations which would have been otherwise impracticable. It is very desirable that all persons occupied with the same or analogous problems should meet periodically, in order to fix ideas and coordinate individual efforts, without in any way restricting personal initiative. It may be asserted with satisfaction, added Dr. Hildebrandsson, that the meteorological conferences organised more than thirty years ago have materially contributed to the development of the science, to uniformity of views, and to agreement between the services of different countries. The constitution of the international committee contributes effectively to the maintenance of good relations, and promotes continuity in the labours of the conferences.

Dr. J. Hann was elected honorary president, and Dr. J. M. Pernter president, of the conference. In the course of an address Dr. Hann said:—

As I am not the official president, I shall take advantage of my privilege of passing over in silence most of the questions which form the programme of the present conference, and I shall devote my attention to certain problems of modern meteorology in which I have a special interest, and the solution of which your discussions will assist.

The use of balloons and kites has brought the exploration of the upper regions of the atmosphere to a degree of development of which we had no idea at the time of the first international congresses at Leipzig and Vienna. Even in 1879 the condition of the question had not changed, when at the congress at Rome I was charged with elaborating plans for observations in balloons and on mountains. We had not then the apparatus for raising kites, and had no idea of the important part they were to play in meteorological science. It was reserved for Messrs. Rotch and Clayton, of Blue Hill, to obtain the excellent results with which we are all acquainted.

Further, unmanned balloons were not invented, which since, thanks to M. Teisserenc de Bort, have furnished such surprising data relating to the temperature of the upper regions of the atmosphere. The exploration of the air by means of manned balloons was carried on without any regular plan, and the observations obtained, as we found out later on, were unsuitable for scientific investigations. It was only more recently, after the older experiments by Welsh had been overlooked and forgotten, that Dr. Assmann produced his aspiration-thermometer, which is capable of giving accurate temperature observations during balloon ascents.

Thus I was only able to recommend observations in captive balloons. I directed attention to the superiority of such observations over those made on mountain summits, which were subject to the disturbing influence of the ground, and gave a daily range of temperature quite different from that observed in free air.

But as observations in captive balloons were limited in several respects, I also recommended that observations should be made on mountains. Mountain observations, although subject to local influences, are of great use; they give us information that observations made in balloons or by means of kites cannot do, viz. the continuous registration of meteorological elements (especially barometric pressure) at a definite altitude, and are indispensable in determining the conditions of the weather in the higher regions of the atmosphere.

I now come to another domain of research, which at the present time has attained increased importance, viz. the problem of weather periods and their connection and dependance on the activity of the sun. This is one of the grandest and most beautiful problems of modern meteorology, for the solution of which astronomers, physicists, and meteorologists must give mutual assistance. One of the services which meteorologists can render in furthering this important object is to obtain suitable observations, by means of which the cyclical variations in the atmosphere and their relations to solar activity may be unequivocally determined.

These observations must fulfil two principal conditions; they must be distributed as uniformly as possible over the globe in order to give sufficient data relating to the conditions of the atmosphere at fixed moments, and must be suitable for closely following the variations in time of these conditions during short as well as in very long periods. The meteorological observations at fixed points must give continuous and homogeneous series of mean and extreme values.

Unfortunately, the older observations do not always satisfy these conditions. It often happened that the principal meteorological observatories, while constantly endeavouring to obtain more exact data, omitted at the same time to take steps for obtaining comparisons between the old and the new series of observations. This remark applies above all to certain barometrical observations. Thermometrical observations subject to local influences, as well as barometrical observations affected by large or unknown instrumental errors, may afford valuable means for determining the variations of meteorological elements, provided that the local influences and the corrections are

constant. These are even more valuable than absolutely accurate observations that are not homogeneous, because the constant errors do not affect the variations. Accordingly I have for many years urged in the *Meteorologische Zeitschrift* that we should endeavour to continue the homogeneous series of means and extremes of the meteorological elements for as many years as possible, and should collect and critically discuss the older series of observations.

Considered from this point of view, the continuation of meteorological observations on mountains is of special value and most urgently to be recommended. They give us information about the condition of the atmosphere in the higher regions which are less exposed to local influences.

Among the results of recent researches, no other has made so great an impression on me as the observations of the British Antarctic Expedition on the retrograde motion of the glaciers now going on in those regions. The renowned great ice-barrier of James Ross has receded thirty miles; the glaciers of Victoria Land are in full retreat, and no longer reach the sea; while, on the other hand, the Arctic glaciers are receding, and travellers report the same thing about the glaciers of the snow-covered mountains of Ecuador and East Africa.

Comparing these facts with reports and observations of the progressive desiccation of Africa and Central Asia, we are confronted with one of the greatest problems of terrestrial physics. This appears the more difficult of solution since we have similar phenomena on a smaller scale which we can closely observe, both as regards geographical and time distribution, but are unable to explain from a meteorological point of view. I refer to the continual retrograde motion of the glaciers of the Alps, which you have the opportunity of seeing in the vicinity of the place of our present meeting. Although this phenomenon is proceeding in a district where one may suppose sufficient meteorological observations, both as to time and geographical distribution, are available, we are still unable to determine with certainty a direct connection between the variations or periods of the meteorological elements and the movements of the glaciers.

Great results are not attained suddenly, but only after long and carefully prepared efforts. You have met here, gentlemen, to deliberate upon the means by which we may solve, step by step, the most important meteorological problems of the present day.

Dr. Pernter proposed that a certain number of questions should be referred to special subcommittees which would present reports, with the view of simplifying discussions at the general meetings. Subcommittees were nominated for the consideration of (1) an international code and comparison of the standard barometers of different countries; (2) new edition of the cloud atlas, and the classification of clouds; (3) reduction of the barometer to sea-level, and questions relating to weather-telegraphy; (4) international study of squalls.

A vote of thanks was accorded to Dr. Hildebrandsson for his services as secretary to the International Meteorological Committee, and a telegram was dispatched to M. Mascart, president of the committee, expressing regret at his absence owing to ill-health.

An account of the subsequent meetings of the committee will appear in another issue of NATURE.

SCIENCE TEACHING IN ELEMENTARY SCHOOLS.

THE issue by the Board of Education of the Blue-book[1] that lies before us is a promising sign. Intended as a supplement to the necessarily somewhat rigid and mechanical "Code," it indicates the progress which rational ideas upon elementary education have made in the national councils since the days when Robert Lowe's scheme of "payment by results" could claim rank as a piece of wise statesmanship. The opening words of the "Prefatory Memorandum" show the cautious and reasonable spirit in which these suggestions are made:—

"In issuing this volume the Board of Education desire at the outset strongly to emphasise its tentative character, and to invite well-considered criticism designed to make it more useful for its special purpose."

The Blue-book contains an introduction on the objects of elementary schools, organisation, the curriculum, and the methods applicable to children of different ages, followed by chapters on the teaching of particular subjects, viz. English, arithmetic, observation-lessons and nature-study, geography, history, drawing, singing, physical training, needlework and housecraft, handicraft and gardening, and hygiene. Specimen schemes for most of these subjects are given as a series of appendices.

The suggestions made for arithmetic are of a wise and practical kind, as a few extracts will show:—

"The instruction in arithmetic should be made as realistic as possible. . . . The use of sets of objects will make it possible from the very beginning to teach the children to add, rather than count by units. . . . Multiplication tables should not be learnt before they have been constructed and understood. . . . Every school should be provided with (*a*) foot-rulers graduated. . . (*b*) cords with feet, yards and metres marked upon them, . . . (*d*) a pair of common scales with the smaller weights . . . (*e*) measures of capacity . . . (*f*) squared paper or tracing cloth. . . . The commercial applications of arithmetic commonly found in text-books could be advantageously replaced by algebra, practical geometry and the mensuration of the simpler solids and surfaces."

The chapter on observation-lessons and nature-study emphasises the importance of training in accurate observation and accurate description. The distinction made between the two terms is that observation-lessons are for children under ten, while nature-study is for older ones. This seems an artificial distinction, apparently involving the thesis that by the tenth year there is nothing left for observation by the pupils in elementary schools except the outdoor world. The movement of late years for nature-study has, in fact, involved a confusion of thought between subject-matter and method; and it has come to pass that on the one hand didactic teaching of elementary botany, provided it is accompanied by practical verification, and on the other almost any sort of heuristic teaching, are equally covered by that vague and comprehensive term. We see some trace of this confusion of thought in the following remarks:—

"The main factor which marks off nature-study from other school subjects should be that in it the instruction proceeds solely from the actual object, and never from description or reading. In practically every other subject, no matter how successfully the teacher makes the scholar look for the information he requires, the child has to take things for granted, and must depend on the good faith of the teacher or of the printed book; in nature-study comes the opportunity of proceeding by another method and teaching from the thing itself. The teacher should then be very jealous not to waste this unique opportunity" (pp. 48–49).

If this be interpreted as an attempt to use nature-study as an heuristic wedge to be driven into densely didactic school traditions, we may approve of its practical purpose; but with the more idealistic tone of the whole book it is inconsistent. The whole of the chapter on arithmetic is saturated with the notion of "teaching from the thing itself." So far from

[1] "Suggestions for the Consideration of Teachers and others concerned in the Work of Public Elementary Schools." Pp. 156. (1905.)

nature-study affording an unique opportunity for heuristic teaching, the very complexity of the problems which its subject-matter presents puts it at a disadvantage as compared with the simpler problems of elementary physics and chemistry.

Again, how can we reconcile the foregoing quotation with the following, which precedes it by a few pages?

"When a dog has been used as the subject of an observation lesson, the children may read, or be told, about the wolf or the fox. This will lead them to compare and contrast, and will aid in stimulating imagination" (p. 46).

Must we say that the dog is part of "nature" while the wolf and fox are not? or that methods bad for children over ten are allowable below that age? or must we simply explain the difference as due to composite authorship, permissible in a book of suggestions (not instructions), coupled with some confusion of mind on the part of one author between method and subject-matter?

The true idea of the relative positions which heuristic and didactic methods should occupy, which to our mind is well illustrated by the above simple case of the dog and the wolf, is clearly expressed in the chapter on geography:—

"In order that the study of geography may be of real educational value it must not be regarded as a process by which certain facts about the earth . . . are committed to memory. It must be rather regarded as the subject, which above all others brings the youngest child as well as the most advanced student into contact with the outside world. . . . It is true that as we advance in the study of geography we have to rely, to a great extent, upon the investigations of others, but in order that they may understand these investigations we must from the very first teach children to work for themselves and to take nothing for granted."

Nevertheless, it is not suggested that early geographical teaching shall be purely heuristic. On the contrary, the value of stories of strange and distant countries is strongly urged. At first these are scarcely differentiated from fairy-tales, but with each succeeding year they become more exact, until they at length pass into definite geographical teaching for which an observational basis has meanwhile been prepared. Here we see a development of the idea of the relation between didactic and heuristic teaching. It is useless and unnecessary to think, even as a remote ideal, of the exclusion of the former; all that is necessary is to prevent it from being more precise in character than is justified by the stage attained in the latter.

History, in spite of authoritative opinion to the contrary, we must regard as a science, but one in which heuristic teaching is out of the question. Like the one side of geographical teaching, it grows out of fairy-tales, and there need be no scruple in telling young children traditional stories that have not survived modern critical research. But we are glad to see that visits to local places of historical interest are recommended, and that in one at least of the schemes suggested in the appendix the syllabus for the highest class includes "first notions on the materials of history and the use of evidence." Unfortunately, very few teachers will have had any opportunity of acquiring the necessary knowledge on this subject. A book treating in a simple manner of the materials of history—and by no means confined to the documentary portion—is much to be desired.

To sum up the ideas we have so far gathered, we venture to think that in some future edition of these "suggestions" the division into subjects will perhaps be largely abandoned, and in its place we shall have a division by methods which will by no means coincide with groups of the present subjects. Even the official time-tables may come to recognise this. On the one hand we shall have heuristic teaching, aiming primarily at training the mind in scientific habits of thought, and incidentally imparting knowledge; on the other hand, didactic teaching to impart knowledge which is wanted but cannot be obtained at first-hand—its scope being carefully adapted to the stage reached in heuristic training. But, alongside of these two methods, there still remain a number of other subjects, which do not fall under either of these heads, since they consist in training or drilling of some description, *e.g.* the use of the mother tongue, singing, handiwork, and health-training. This last, we agree with the writers of the Blue-book, it is not advisable to teach to young children on a physiological basis. Hygienic habits must be learnt before the age at which physiological laws can really be understood, since some knowledge of physics and chemistry is essential to their real understanding; and to attempt to teach them without such a basis is only to give false knowledge, which is only too likely to prevent the acquisition of true knowledge in later years.

A. M. D.

A NEW ULTRA-VIOLET MERCURY LAMP.

UNDER the name of "The Uviol Lamp," Dr. O. Schott, of Jena, is introducing a modification of the Cooper Hewitt mercury vapour lamp, which appears likely to prove useful. The illuminating power of these lamps is very high, and the arc is very rich in ultra-violet rays, but the glass envelope hitherto prevented the passage of many of these actinic radiations. Dr. Zchimmer has recently produced at Jena glasses which are pervious to the ultra-violet rays, and Dr. Schott has made the envelope of the new lamp of this material.

The Uviol lamps consist of tubes of this special glass of 8 to 30 millimetres diameter and 20 to 130 centimetres length. Platinum wires are fused into the extremities, terminating in carbon heads. In the glass tube there is a charge of mercury of 50 to 150 grs., according to the size. The lamps of various sizes, with their resistance and choking coils, can be connected with electric mains of 220 or 110 volts.

To start the arc, the lamp is tilted to a sufficient degree to allow of the mercury in the tube passing from one pole to the other. At the moment of contact between the pole and the mercury, part of the latter is disintegrated simultaneously with the formation of a column of light. The carbon and heads to the poles permit the passage of the current in either direction without fusing the platinum poles. To get the best results from a current of 220 volts the lamp tube must be 130 centimetres long, but two or three suitable shorter lamps may be arranged side by side or one behind or over the other.

The spectrum of the Uviol lamp is exceedingly rich in lines. The lamp is particularly suitable for taking photographs and for copying processes by artificial light. Experiments have also been made in testing by its means if certain colours used in dyeing and printing have sufficient power to resist the fading effects of the sun. It will thus prove of value in rapidly settling the question of the fastness of colours, which will in future require days instead of months.

The Uviol lamp is also a germicide, and it appears likely that it will prove of value in the treatment of certain diseases of the skin. It is an irritant, and easily sets up inflammations, particularly of the eyes, so that the greatest care must be taken by operators

by means of suitable spectacles. With tactful handling it is said that the Uviol lamp can be used for 1000 working hours without loss of efficiency. The cost of a 400- to 800-candle lamp is 1*d.* to 2*d.* per hour. It thus appears to be a very economical method of converting electrical energy into efficient radiating energy of short wave-length.

NOTES.

THE opening of the bridge over the Victoria Falls on September 12, and the visit of the British Association, were celebrated by a banquet, at which Mr. Newton, representing the British South Africa Company, in proposing the health of Prof. Darwin, welcomed the association on the anniversary of the first occupation of Mashonaland by pioneers fifteen years ago, fifty years after Dr. Livingstone first saw the falls. Prof. Darwin proposed the toast of Sir Charles Metcalfe, representing the great enterprise which to-day marks an important step in advance. Reuter's Agency reports that Sir Charles Metcalfe, in the course of his reply, read congratulatory telegrams from Lord Grey and the directors of the British South Africa Company, and a telegram from Mr. Reunert, president of the South African Association of Sciences, conveying his congratulations that more links had been formed in the chain of civilisation. On September 15 the association received a hearty welcome at Salisbury (Rhodesia). The town was decorated, and the trains were met at the station by the local authorities, headed by the Mayor, the Acting Administrator, and the Resident Commissioner. At a subsequent luncheon the Mayor, in welcoming the members of the association to the most northern part of their tour in South Africa, directed attention to the progress made since the occupation of Rhodesia fifteen years ago. When the many diseases which affect the cattle of the country have been conquered, it is hoped that stock-raising will develop very rapidly. In the course of his reply, Prof. Darwin remarked that when the papers and lectures dealing with the special features of South African scientific work are published, it will be seen that serious efforts have been made to grapple with these problems. Sir Thomas Scanlen welcomed the association on behalf of the Chartered Company; and Lord Rosse and Sir William Crookes also spoke. On September 16, at Umtali, a deputation headed by Senhor de Sousa, secretary of the Governor of Mozambique, met the section of the British Association proceeding to Beira. Senhor de Sousa welcomed the members of the association to Portuguese territory in the name of the Governor, the Mozambique Company, and the inhabitants of Beira. On September 17, at Beira, the visitors attended a reception given by the Governor, and were entertained at luncheon. At 4 p.m. on the same day the party left for home on the steamer *Durham Castle*. We regret to learn that Sir William Wharton, a member of the British Association party which is returning home *viâ* Cape Town, is lying ill at the observatory there, having contracted a serious chill.

FOR the past two years cholera has steadily been proceeding westward, and during 1904 had manifested itself in Asiatic Turkey, Persia, and Russia. Since then cases have been recognised in Germany and Austria, and already 179 cases, with 65 deaths, have been recorded in Prussia. A considerable responsibility, therefore, rests on our frontier guards, the port sanitary authorities throughout the kingdom, particularly in view of the number of aliens who reach our shores from the region of the infected districts. If cholera unhappily should reach us, it is not likely to cause any serious epidemic. The last epidemics of note in this country were in 1828, 1848, and 1859.

IT is announced in the *Bulletin de la Société d'Encouragement* that next month a museum of industrial hygiene will be opened in Paris by the President of the Republic. The creation of the museum was authorised by a decree of December 24, 1904. Accommodation for the museum has been found at the Conservatoire des Arts et Métiers, and the sum of 41,000 francs considered necessary for the installation has been collected, as well as subscriptions to cover the annual cost of upkeep. The exhibition will be a permanent one, and, being a loan collection, will be constantly renewed.

THE sixth congress of criminal anthropology will meet at Turin on April 28, 1906, under the presidency of Prof. Lombroso. An exhibition of criminal anthropology will be held in connection with the congress.

DR. OSCAR MAY died at Frankfort-on-the-Main on August 25 at the age of fifty. Dr. May (says the *Electrician*) was one of the founders of the Elektrotechnische Lehr- und Untersuchungs-Anstalt of Frankfort, and was until 1895 instructor in electric lighting at that institution. At the Frankfort Exhibition in 1891 he was a member of the presiding committee and one of the secretaries of the scientific commission.

WE learn from the *Victorian Naturalist* that the estimates recently presented to the council of the University of Melbourne contain, among other proposals of a scientific nature, provision for the erection of a botanical laboratory and the appointment of a professor of botany, who, it is proposed, shall also act as Government botanist. This arrangement, remarks our contemporary, should ensure the best use being made of the valuable collection of Australian plants in the National Herbarium.

A LETTER from Prof. David Todd, dated September 8, informs us that the print of the solar corona of August 30 which was reproduced in last week's NATURE (p. 484) was from an early developed negative done during the heat of the Sahara *gibleh*, and was inferior to others developed after the weather turned cool again. He sends us one of these original negatives, which shows a large amount of detail that did not appear in the print reproduced in NATURE. The automatic machine with which these exposures were made took about seventy-five negatives during totality, of which sixty-three proved to be useful for executing drawings of the corona.

DURING the past few days earthquake shocks have been felt in various parts of Italy. The following is a summary of Reuter messages published in the daily papers:—*September* 13, *Innsbruck*.—Severe shock felt in the Arlberg district at 1.30 a.m. Duration, from six to ten seconds, and direction from south to north. *September* 14.—Shock felt at 10.10 a.m. at Racidena, Messina, Reggio di Calabria, and Mineo; recorded on the seismic instruments at all the observatories in Italy. Another shock felt at Reggio (Calabria) at 12.33. *September* 15.—Mount Vesuvius is becoming increasingly active. During the day frequent undulatory shocks were felt in the region around the volcano. The activity of Stromboli is also very remarkable. *September* 16, *Innsbruck*.—Severe shocks felt in the Arlberg district at 4.3 a.m. and 4.37 a.m. First shock lasted five seconds and the other four. The shocks were accompanied by loud rumblings. *September* 17, *Monteleone*.—Shock felt at 1.40 p.m.

September 18.—Sharp earthquake shocks were felt at 3 a.m. and 11.15 a.m. at Reggio (Calabria). Further damage was done in the provinces of Catanzaro and Cosenza. A severe shock was felt at Monteleone.

THE deaths of two well known explorers were announced in the *Times* of Saturday last. M. de Brazza died at Dakar on September 14 in his fifty-third year, and Captain J. Wiggins at Harrogate on September 13 in his seventy-fourth year. De Brazza was sent in 1875, accompanied by Dr. Ballay and M. March, naturalist, to explore the Ogowe, the great river in Gabun in Equatorial West Africa. During the succeeding eight years he laid the foundations of the French Congo Protectorate. A second visit to West Africa, which lasted for three years, was made in 1879, and during this time de Brazza persuaded King Makoko to place himself under the protection of the French flag. Successive journeys were made to the same regions in 1883 and 1887. After an expedition in 1891–2 from Brazzaville to the Upper Sungha with the view of opening up a route to the Shari and Lake Chad, de Brazza settled down in France. Last April he was sent out as commissioner to inquire into the charges of maladministration in French Congo territory, but the hardships incident to travel in the malarial tropics of Africa this time proved fatal. To Captain Joseph Wiggins belongs the credit of having discovered, or at least rediscovered, thirty years ago a new ocean highway within the Arctic circle by which the trade of European Russia obtained for the first time direct maritime access to the navigable rivers of Siberia. Captain Wiggins was a Fellow of the Royal Geographical Society.

THE thirteenth annual exhibition of the Photographic Salon is now open at the Gallery of the Royal Society of Painters in Water Colours, Pall Mall East. It contains many very fine examples of photography which will interest the scientific student in showing what can be done by means of modern methods. The aim of the promoters of the exhibition is purely pictorial, and although presumably all the works shown are produced by photographic means, it is obvious that there is some, and in a few cases probably a great deal of hand-work in addition. This detracts to a certain extent from the value of the representations of the various phases of nature, of which there are several interesting examples. The methods employed are quite outside the consideration of the society responsible for the show; we can therefore only surmise that the majority of the multi-coloured pictures, and there are about a dozen of them, are made by the gum-bichromate process, applying from two to five coatings of different colours as desired. But the portrait of Frederick Hollyer by Mr. F. T. Hollyer is probably printed on platinum paper, the colours being obtained by modifications in the method of development or by subsequent treatment of the print. A picture so made is obviously not a platinum print, and its permanency and other characteristics must depend entirely upon the nature of the pigmentary materials present. We do not notice any example of "photography in natural colours" as this phrase is commonly understood.

THE greater part of the *Naturwissenschaftliche Wochenschrift* for August 27 is devoted to a review, by Dr. Thesing, of the pathogenic protozoa, dealing particularly with the subject of syphilis.

THE *Popular Science Monthly* for September contains many interesting articles. Messrs. Foulk and Earhart discuss State university salaries, and deplore the meagre remuneration of university teachers. If this be the case in America, how much more so is it in this country?

WITH reference to the article on "The Sterilisation of Water in the Field" (August 31, p. 431), the Lawrence Patent Water Softener and Steriliser Company writes to say that a mistake was made in the records of the official trials of water sterilisers, and that the Lawrence steriliser never consumes more than 1½ pints of kerosine per hour, not 2 pints as stated.

THE *Psychological Bulletin* for August (ii., No. 8) contains an important review by Dr. Meyer of Prof. Wernicke's monograph on aphasia, together with an obituary notice of Prof. Wernicke, who was killed on June 15 in a bicycle accident. We would suggest that the Bulletin be issued with cut pages in future.

THE *Revue de l'École d'Anthropologie de Paris* for August contains an article by MM. Capitan and Papillault on the identification of the body of Paul Jones 113 years after death. This was based partly on general characters, colour of the hair, &c., partly on measurements compared with those of certain contemporary busts, between which there was an extraordinary agreement, and partly on pathological details. There were clear indications of broncho-pneumonia, of tuberculosis, and of renal disease, and from contemporary records it is known that Paul Jones suffered from all of these.

LIEUT. CHRISTOPHERS, I.M.S., records a discovery of considerable interest, viz. the presence of a parasite belonging to the hæmogregarines in blood of the Indian field rat (*Gerbillus indicus*). Hitherto it has been believed that these parasites are confined to cold-blooded vertebrates. The parasite occurs as a motionless vermicule in the red blood cells, and as an actively motile vermicule in the plasma. Infection of the rat was proved to take place through its parasitic louse, a new species of Hæmatopinus, in which a developmental cycle is passed (*Sc. Mem. of the Gov. of India*, No. 18).

WE have received from the director of the Government Zoological Gardens at Giza, near Cairo, a list of a collection of animals obtained by the members of the staff during a collecting trip to the Sudan, which lasted from May 10 until August 10. The list comprises 129 animals referable to 46 species, among which a pair of Senegal storks are perhaps the most notable. It should be added that several of the specimens are the gifts of officials in the Sudan, and that a giraffe was confided to the care of the director by the Khedive.

To the first part of vol. ix. of the *Biological Bulletin* Dr. J. E. Duerden contributes a sixth instalment of his account of the morphology of the Madreporaria, dealing in this instance with the "fossula" of the extinct rugose corals. The fossula (of which there may be several), we may remind our readers, is a very characteristic feature of the Rugosa, and consists of a pit in the calice due to the smaller size of the vertical septa in that particular area. In this communication the author endeavours to explain the structure of this pit from the changes which take place in the corallite during development.

IN the August number of *Naturen* Mr. H. Schetelig describes, with illustrations, certain very interesting remains of buildings of Neolithic age which have recently been opened up in Scandinavia. The building takes the form of a portion of a curved wall situated in a stratum below the peat, which is itself overlain by a considerable

thickness of more recent deposits. Alongside the wall were found a number of stone implements, most of which are of the well known Neolithic adze type, although others are chiefly finished by chipping, and appear in some degree transitional between Palæo- and Neo-lithic types.

IN the first article of the August issue of the *American Naturalist* Prof. D. P. Penhallow discusses the ancestry of the poplars and willows (Salicaceæ) as deduced from the woody structure of the fully mature stem. The family appears to be of Old World origin, and while most of its Cretaceous representatives appear to have been suited to a warm climate, the tendency of the later forms appears to have been to adapt themselves to boreal conditions. The other articles include the seventh part of Dr. B. M. Davis's studies on the plant-cell, and a dissertation by Mr. J. A. Cushman on the developmental history of the shelled foraminifera of the group Lagenidæ. For the initial chamber of these lagenoids the author proposes the name "proloculum," on the analogy of "protoconch" in the case of the gastropod shell.

THE trustees of the British Museum have caused to be issued (at the price of 3*d.*) a special guide to an exhibition of old natural history books now placed in the main hall of the Natural History Museum in Cromwell Road. The object of the series is to illustrate the origin and progress of the study of natural history previous to Linnean times. Apart from reproductions of certain prehistoric sketches, which scarcely, it seems to us, come under the designation of "old natural history books," the series commences with Aristotle's natural history, followed by other works collectively assigned to the classical period. Arab philosophers, such as Serapion of the eight or ninth century, come next, and following these, after a brief reference to a few mediæval writers, we are introduced to the works of Leonardo da Vinci and the early "herbalists." With the close of the fifteenth century the legendary period of natural history gave place to an era of first-hand investigation, and special reference is made in the guide to Wotton (1492–1555), the first English physician to make a scientific study of the subject, and to whom belongs the credit of restoring zoology to the rank of a science. For the history of later writers and their works we must refer our readers to the exhibition itself, which, if studied by the aid of the excellent little guide before us, cannot fail to prove both interesting and instructive.

UNDER the conditions which prevail, it is too much to expect any great expansion of forest areas in the British Isles, but there is some consolation in the statement made by Mr. G. Pinchot, the energetic chief of the Bureau of Forestry in the United States, that the Canadian and Cape Colonies have established an efficient forest service, and that Australia and New Zealand are making progress in the same direction. Mr. Pinchot reviews the conditions of forestry in Germany, France, and Switzerland, also in British India and the United States, in the August number of the *National Geographic Magazine*. Among the illustrations are some depicting the employment of elephants in the teak trade of Burma.

AN account of the Erysiphaceæ of Japan in the *Annales Mycologici*, vol. iii., No. 3, by Mr. E. S. Salmon, affords some instances of distribution which are not readily explained. Four species were previously only known from America, one each from Australia and China, and five are endemic. One species, *Uncinula geniculata*, was gathered near Tokio on an endemic plant, *Styrax Obassia*; as recorded from America, the only host-plant is *Morus rubra*. Mr. Salmon suggests that possibly *Morus rubra* will be found to exist in Japan, or that the area of distribution of the two host-plants may have overlapped, or that the fungus, having been introduced to Japan, has spread to a new host-plant.

THE sixteenth annual report of the Missouri Botanical Garden contains three papers on fungal diseases observed on cauliflowers by Dr. H. von Schrenck and Mr. G. G. Hedgcock. Following upon the treatment of the cauliflower leaves with different fungicides, it was noticed that swellings were raised in certain cases; further experiments proved that these were caused by the application of a solution of copper ammonium carbonate which induced extravagant enlargement of the mesophyll cells. Prof. Sorauer, who has treated the subject of intumescences very fully, has referred their formation to the action of an abnormal elevation of temperature, combined with excessive water supply. In the experiments here detailed these conditions did not obtain, and Dr. Schrenck shows definitely that the swellings are the result of chemical stimulation brought about by the copper ammonium salt when applied in a dilute solution, and he compares it with the well known action of poisonous salts, which in weak solutions induce acceleration of growth.

THE August number of the *Fortnightly Review* contains an article by Mr. W. H. Mallock on the two attacks on science. The two attacks are the clerical and the philosophic, and the writer contends that the former of these has failed entirely, because man and the universe, when studied as modern science studies them, neither can have, nor require to have, any other explanation than that which science offers us, the principle, namely, that all phenomena result from a single system of interconnected causes. There are no longer gaps in which the divine interference can be seen, for even the gap between the organic and the mental has been bridged over by the discovery that consciousness and mind are by no means co-extensive and identical, *i.e.* that consciousness is not essential to the existence and operations of mind. As for the philosophic attack, the main problem is that of the origin of ideas, and Mr. Mallock accepts the scientific view that the mind is a highly complex organism, having a long pedigree, and evolved from simpler elements; that the "connection of things" gradually reproduces itself in the "connection of ideas"; that the individual is at no point to be regarded as separated from the cosmic whole, but that even conation, which has sometimes been supposed to differentiate mental from other processes, depends on the universal conation of nature. On these lines science extends indefinitely the borders of what we call self, and breaks down the dividing line between ourselves and the universe; and thus introspective philosophy "instead of disintegrating science as a system of childish materialism, merely hardens and sublimates it into a system of universal mentalism."

WE have received an effective relief map of the Dominion of Canada, on a scale of 100 miles to an inch, published by the Department of the Interior.

A RECENT Bulletin (No. 15) of the Geological Commission of Finland contains a series of chemical analyses of ninety-one igneous rocks from Finland and the Kola peninsula. The analyses are set out and the rocks classified according to the elaborate new method of the American petrographers (Whitman Cross, Iddings, Pirsson, and Washington), in whose work many of these analyses have already appeared. Thirty-eight, however, are new, being mostly the work of Miss N. Sahlbom.

THE Geological Survey continues its work of unravelling the complex structure of the Highlands, and has lately published a memoir on the region of the Upper Tay and Tummel valleys (Sheet 55, Blair Atholl, Pitlochry, and Aberfeldy), a region where the newest and the oldest of geological formations alone are found. Most of the memoir is occupied with the field relations and petrography of the crystalline schists and igneous intrusions, but glacial and alluvial deposits are also described. Chief among the illustrations are seven very fine photographic plates. One of the most interesting is a view of the rocky bed of the Garry, with the curious "water-pipe" structure, due to unsymmetrical folds in the Moine gneiss. An example of the practical utility of the survey is given in the fact that the basalt quarries near Aberfeldy, which supply the best road-metal in the district, were started at the suggestion of a survey officer.

THE Geological Survey of Ireland has recently been transferred from the charge of the Board of Education to the Department of Agriculture and Technical Instruction, and in connection with the transference an interesting article describing the survey's history and work has been contributed by Prof. Grenville A. J. Cole to the department's journal. In this article mention is made of the fact that so long ago as 1837 a laboratory for the examination of soils was established in Belfast, and a soil survey was projected. Unfortunately, however, the authorities were unsympathetic, and Ireland has not the credit of the first soil survey. "It was left," writes Prof. Cole, "for Germany, the United States, Japan and other countries to develop agricultural geology as a branch of organised research." Under the care of Sir Horace Plunket's vigorous department, it is safe to predict that the survey will now make amends to Irish agriculture for the neglect of 1837.

WE have received the report of the United States Geological Survey on the results of primary triangulation and primary traverse for the fiscal year 1903–4, by Mr. S. S. Gannett. Prefixed to this is a valuable chart showing the "condition of astronomic location and primary control" in the United States up to April 30, 1904.

THE new number (vol. xviii., part i.) of the *Mitteilungen aus den deutschen Schutzgebieten* contains a paper of interest to surveyors on a method of measuring a base-line, in sections of about 40 metres, by means of a 4-metre subtense rod and theodolite, by Herr H. Böhler. The reduction of the observations is dealt with in detail, and Captain Kurtz contributes a separate note on a special method. The general result points to an error of about $\pm 7 \cdot 4$ mm. per kilometre.

WE have received No. 8 of the "Current Papers" presented to the Royal Society of New South Wales. Nearly two years have elapsed since the last of these papers was communicated by Mr. H. C. Russell, F.R.S., and on account of his illness the present number has been drawn up by Mr. H. A. Lenehan, the acting Government astronomer for the State. The Federal postal regulations having done away with the system of "franks" for Government documents, the number of observation records received diminished by about 60 per cent. in 1904 as compared with the average for the period 1899 to 1903. Several records are, however, of great interest, notably that of a float cast adrift off the coast of California, and picked up on the island of Boillon in the Java Sea, after a journey of 11,350 miles.

STANDARD sections for rolled iron were used first in Germany in 1879 and in the United States in 1897. In Great Britain the Engineering Standards Committee was appointed in April, 1901, by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron and Steel Institute, and the Institution of Naval Architects to inquire into the advisability of standardising rolled iron and steel sections for structural purposes; and although the time has not yet been sufficient for the standard sections to be adopted as widely as they are in Germany, the committee has done admirable work, and with the support of the Institution of Electrical Engineers important developments are being made in other fields. The latest reports received, namely, No. 16, "British Standard Specifications and Tables for Telegraph Material" (London: Crosby Lockwood and Son, 1905, price 10*s*. 6*d*. net), and No. 23, "British Standards for Trolley Groove and Wire" (London: Crosby Lockwood and Son, 1905, price 1*s*. net.), are striking examples of the wisdom displayed by the committee in not going too far in the direction of standardisation. In the case of telegraph material it is not considered necessary to issue a specification for copper wire. No attempt has been made to standardise submarine or underground tables, nor telegraphic or telephonic apparatus; and in the case of trolley wire it has not been deemed advisable to go further in the direction of standardisation than the recommendation of certain figures for the minimum tensile breaking strength for the gauges of wire in general use. No attempt is made to standardise any particular design of trolley wheel, the committee having confined itself to recommending a groove of a certain section. In short, these standard specifications are so reasonable that they cannot fail to meet with general adoption, as economy in production is ensured without any revolutionary change or any restraint on originality of design.

AT the last meeting of the Faraday Society (held on July 3) a paper was presented by Prof. E. Wilson upon "Alternate Current Electrolysis." The author has carried out a long series of experiments with alternating currents, using various metals as electrodes, and various metal salt solutions as electrolytes. The loss or gain in weight of the electrodes during the experiments was recorded, and accurate measurements of the potential difference and of the current intensity were also made. The exact potential difference between the electrodes was obtained by use of an exploring electrode placed between the plates and a quadrant electrometer. The following metals were experimented with:—lead, zinc, iron, copper, tin, and aluminium. The frequency of the alternating period, the density and character of the electrolyte, and the current intensity were varied during the experiments with each metal. The results obtained are gathered together in tabular form in the original paper, and these show that the loss of weight was greatest in the case of lead in a dilute sulphuric acid solution, and least in the case of copper. The discussion on this paper has been adjourned until the meetings of the society are resumed in November next.

THE Cambridge University Press has just published an index to the volume containing Lord Kelvin's "Baltimore Lectures on Molecular Dynamics and the Wave Theory of Light," reviewed in NATURE of May 5, 1904.

A FOURTEENTH edition of "Mineralogy," by the late Mr. Frank Rutley, has been published by Messrs. Thomas Murby and Co. The book has been revised and corrected, and a brief notice of the radio-active elements, contributed by Mr. Ernest H. Adye, has been added.

COPIES of two booklets, which have been published privately by Mr. F. W. Armstrong, of the Blue School, Wells, Somerset, have been received. They deal respectively with elementary inductive chemistry and inductive physics.

A NEW catalogue of physical and electrical instruments, balances, &c., has been issued by Messrs. W. G. Pye and Co., of the "Granta" Works, Cambridge. The excellent illustrations, drawn to a larger scale than is usual in similar publications, should greatly assist customers ordering instruments from a distance, since with the accompanying concise explanations little room is left for misapprehension.

OUR ASTRONOMICAL COLUMN.

THE VARIABLE ASTEROID 1905 Q.Y.—From a telegram from Dr. Palisa to the Kiel Centralstelle, it appears that the asteroid which, on the supposition that it was a newly discovered one, was designated 1905 Q.Y., is identical with that known previously as (167) Urda. The identity is confirmed by Prof. Berberich, who writes that on August 28 the magnitude of Urda was from 0·5m. to 1·0m. brighter than shown by the value given in the Jahrbuch (*Astronomische Nachrichten*, No. 4046).

NOVA AQUILÆ No. 2.—From a note in No. 4046 of the *Astronomische Nachrichten*, we learn that the position first given for Nova Aquilæ was 1m. wrong in R.A. It should have read R.A.=284° 17′ (=18h. 57m. 8s.) instead of 284° 2′ as given, the mistake occurring in the first telegram received at Kiel.

Observing this object on September 5, Prof. Hartwig determined the position, referred to the equinox of 1905·0, as R.A.=284° 16′ 16″ (=18h. 57m. 5·06s.), dec.=−4° 34′ 50″, and found the magnitude to be 10.

FRENCH OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE.—No. 10 (September 4) of the *Comptes rendus* contains the brief reports received from various French eclipse expeditions by the Académie des Sciences.

Prof. Janssen, M. Bigourdan, and MM. Stephan and Trépied, observing at Alcosebre, Sfax, and Guelma respectively, report satisfactory meteorological conditions and successful observations. At the last named place M. Bourget obtained fourteen negatives of the corona, using coloured screens. The parties at Cistierna, Burgos, and Tortosa were less fortunate, clouds interfering with, or totally preventing, observations. The measures of the ionisation of the electric field were, however, carried out throughout the eclipse by the observers at Tortosa. Similar observations were carried out, entirely according to programme and under perfect conditions, at Philippeville, and M. Nordmann, from a preliminary examination of the curves obtained, expects that some very interesting results will accrue when these are finally compared with those obtained on previous occasions. M. Salet, from the same station, reports that the polarisation of the corona was well observed, the deviation of the plane of feeble polarisation being 3°. Ten coronal radiations were photographed with a "Nicol" in front of the slit, and fifteen ultra-violet coronal radiations were photographed with the spectroscope.

From the eclipse station at Alcalá de Chisbert (Spain) M. M. Moye writes that the eclipse was observed under good conditions, and that the corona was very brilliant, the longest streamers occurring in the south and the north-east. The green line was very apparent. Shadow bands were well observed both before and after, but were invisible during, totality.

Observations of the partial phase were made in Paris, where the times of the contacts and of the occultations of spots were recorded by several observers. Unfavourable meteorological conditions prevented the actinometric observations, which it was proposed to carry out at Trappes, Bordeaux, and the Pic du Midi, from being made, but a series of good observations was obtained at Bagnères.

EYE-ESTIMATES OF THE TRANSITS OF JUPITER'S SPOTS.—In order to determine whether his own eye-estimates of the transits of Jupiter's spots were subject to any error similar to that suspected by Schmidt, the Rev. T. E. R. Phillips has analysed his observations, which number about 140, and cover the period of seven apparitions. As a result he has arrived at the conclusion that at the beginning of each apparition, when the planet's hour-angle is east, he observes the transit a little too early. Similarly, at the end of each apparition, when the hour-angle is west, the transits are recorded a little too late. The explanation of this error is that it is due to the varying slant of the belts as the planet is removed from the meridian, and the consequent failure of the eye to determine correctly the position of the line which bisects the disc and is normal to the planet's equator. If this explanation is correct, the error should be of the opposite sense in the two hemispheres, but the evanescent character of the spots in the northern hemisphere has prevented Mr. Phillips from making this test. Again, if the cause suggested is the true one, this error should disappear if care be taken to keep the line joining the eyes parallel to the belts.

In No. 361 of the *Observatory* Mr. Phillips gives the details of his observations during each opposition since 1898, and a diagram which shows the effect of the error referred to above on the observed drift in longitude of the Great Red Spot "Hollow." The hope is expressed that this may lead other observers to elucidate the matter further from their own experiences.

THE SOLAR ACTIVITY, JANUARY–JUNE.—No. 7, vol. xxxiv., of the *Memorie della Società degli Spettroscopisti Italiani* contains Prof. Mascari's usual summary of the solar observations made at the Catania Observatory during the first six months of the current year. A comparison of the "frequencies" observed with those recorded for the latter semestre of 1904 shows that the solar activity was much greater during the later period, but the increase was much more marked during the first quarter of this year than during the second. The daily frequencies of spots, faculæ, and prominences during the six months under discussion were 7·18, 7·12, and 3·29 respectively.

Two plates which accompany this publication show, diagrammatically, the sizes and positions of the prominences observed on the sun's limb at the observatories of Catania, Kalocsa, Odessa, Rome, and Zurich during the last quarter of 1902 and the first two months of 1903.

INSTITUTION OF MINING ENGINEERS.

THE sixteenth annual general meeting of the Institution of Mining Engineers was held at Manchester on September 13, 14, 15, and 16 under the presidency of Sir Lees Knowles, M.P. The report of the council contained an expression of deep regret at the loss sustained by the death of the president, Sir Lowthian Bell. The Institution of Mining Engineers is a federation of seven local mining societies—the Manchester Geological and Mining Society; the Midland Counties Institution of Engineers; the Midland Institute of Mining, Civil and Mechanical Engineers; the Mining Institute of Scotland; the North of England Institute of Mining and Mechanical Engineers; the North Staffordshire Institute of Mining and Mechanical Engineers; and the South Staffordshire and East Worcestershire Institute of Mining Engineers. Since the formation of the institution in 1889, the membership has increased from 1239 to 2901 in 1905.

The first paper read was on the leading features of the Lancashire coalfield by Mr. Joseph Dickinson, formerly H.M. Chief Inspector of Mines. This paper gave a concise summary of the recent developments of the geological investigation of the coalfield. Electric power distribution was dealt with in a paper by Mr. R. L. Gamlen, in which he showed the advantages possessed by the power companies as providers of power. Mr. B. H. Thwaite submitted a paper on colliery explosions in which he suggested, as a method of dealing with explosions, the installation of a series of pipes conveying a supply of oxygen and a pneumatic method of coal-dust removal. The former proposal met with much adverse criticism in

the discussion. Mr. Sydney F. Walker read a paper on earth in collieries, in which he pointed out some of the difficulties in carrying out the special rules drawn up by the departmental committee for the installation and use of electricity in mines. If earth was to be admitted into the system, the only method of carrying out the wishes of the committee was to use an uninsulated return completely enclosing the live conductor. The last paper read was by Mr. John T. Stobbs on the value of fossil Mollusca in Coal-measure stratigraphy. He expressed the opinion that Mollusca afforded the best means of correlating Coal-measures, and considered that their neglect was due to inadequate collections in public museums, and to the fact that teachers failed to impress upon students the utility of the Mollusca as zonal indices. The Coal-measures were, he thought, comparatively neglected by the geologist, the knowledge of the Ordovician, Silurian, and Chalk systems being much more exact than that of the 3000 feet of Coal-measures. The remaining days of the meeting were devoted to excursions to Chanters Colliery, to New Moss Colliery, to the Manchester Museum, to the works of the British Westinghouse Company and the Manchester Ship Canal, to Pendleton Colliery, and to other places of interest.

THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS[1] BY HAROLD WAGER, F.R.S., H.M.I., PRESIDENT OF THE SECTION.

ON SOME PROBLEMS OF CELL STRUCTURE AND PHYSIOLOGY.

Introduction.

WHEN Robert Hooke, in the early part of the seventeenth century, discovered, with the aid of his improved compound microscope, the cell structure of plants, he little thought that our ultimate knowledge of the physical and chemical processes in the living organism, of its growth and reproduction, of the problems of heredity and of the factors underlying the origin of life itself, would be in the main dependent upon a clear understanding of the structure and physiology of the cell.

Hooke's researches did not, in fact, carry him very far, and we must turn to the nearly contemporaneous works of Malpighi and Grew on the anatomy of plants for the first clear indication of the important part which cells take in the constitution of the various tissues of plants. The account they give of them is extremely interesting in the light of our present knowledge. Grew, for example, in speaking of the structure of the root, compares the parenchyma to a sponge, "being a body porous, dilative, and pliable . . . a most exquisitely fine wrought sponge." The pores are spherical and consist of "an infinite mass of little cells or bladders. The sides of none of these are visibly pervious from one into another; but each is bounded within itself. . . . They are the receptacles of liquor, which is ever lucid, and . . . always more thin or watery." There is no indication either in Grew's or Malpighi's works that they understood the significance of this cell structure, and it was not until the beginning of the nineteenth century, after a lapse of some 150 years, that any insight into the real nature of the cell and its functions was obtained. But then began a period of activity—associated with the names of Turpin, Meyen, Robert Brown, Purkinje, J. Müller, Henle, Valentin, and Dutrochet—which culminated in the cell theory of Schleiden and Schwann that the common basis of all animal and plant tissues is the cell, and that it is upon this elementary vital unit that all growth and development depends.

The nucleus was discovered in 1831 by Robert Brown in various tissues of the Orchideæ and in some other families of the monocotyledons, as well as in some dicotyledons. He described it as a "single circular areola, generally somewhat more opaque than the membrane of the cell," and more or less granular. It is very distinct and regular in form, and its granular matter is held together by a coagulated pulp not visibly granular, or, which may be considered equally probable, by an enveloping membrane. Although Robert Brown was the first to recognise the importance of the nucleus, and to give it a name, it had been seen by previous observers, and he himself mentions that he had met with indications of its presence in the works of Meyen and Purkinje, chiefly in some figures of the epidermis; in a memoir by Brogniart on the structure of leaves, and that Mr. Bauer had particularly noticed it in the cells of the stigma of *Bletia tankervilliae,* but had associated it with the impregnation by pollen. There are some figures by Leeuwenhoek, published in 1719, to which Prof. L. C. Miall has directed my attention, of blood-corpuscles of a fish, human epidermal cells, and the connective tissue of a lamb, in which nuclei are shown, and they had been seen by Fontana (1781) in epithelial cells, and by Cavolini (1787) in some fishes' eggs.

To Schleiden and Schwann the cell was essentially a membranous vesicle enclosing a fluid sap and a solid nucleus. They thought that it arose in contact with the nucleus as a delicate transparent vesicle which gradually increased in size and became filled with the watery sap. As soon as it was completely formed, the nucleus, having done its work, was either absorbed or cast off as a "useless member," or in some cases was "found enclosed in the cell-wall, in which situation it passes through the entire vital process of the cell which it has formed." So far from being the most important organ of the cell, as we now consider it to be, they saw in the nucleus merely a centre of cell formation which is no longer required when the cell is formed. It was left for Hugo von Mohl to show that the mucus-like contents of the cell which he called protoplasm (1846) is the real living matter in which reside those activities which call into play the phenomena of life, and that the origin of nuclei by division from a nucleus already existing in the parent cell would possibly be found to occur very widely. Von Mohl, Nägeli, and Hofmeister all appear to have had some idea of the importance of the nucleus in cell division. Von Mohl says that the "process is preceded in almost all cases by a formation of as many nuclei as there are to be compartments in the mother-cell." Hofmeister's description of it is interesting: "The membrane of the nucleus dissolves, but its substance remains in the midst of the cell; a mass of granular mucilage accumulates around it: this parts, without being invested by a membrane, into two masses, and these afterwards become clothed with membranes and appear as two daughter-nuclei."

It is, however, mainly to the researches of the last thirty years that we owe our knowledge of the many complex cell-activities at work in living organisms, and we are still only just on the fringe of the great problems which cytology has to solve. Some of the most important of these are the origin and evolution of the nucleus, the meaning of the complex mode in which the nucleus divides, the origin and nature of the spindle figure and centrosomes, the part played by the chromosomes in the transmission of hereditary characteristics, the meaning of the phenomena accompanying fertilisation, the significance of the longitudinal division of the chromosomes and of their reduction in number in the sexual cells, and the evolution of the living substance. The satisfactory solution of these problems depends upon a clear understanding of the structure of protoplasm and its various differentiations. How far we have succeeded in obtaining this I will endeavour to show.

The Differentiation of Structure in the Cell.

The essential constituent of a cell is the protoplasm. This is differentiated into two constituents, the cytoplasm and the nucleus. It is usually held that this differentiation is an essential one, and that these two constituents are present in all cells; but, as we shall see later, there is some evidence that not only are there cells with very rudimentary nuclei, but cells in which no trace of a nuclear structure can be found at all.

In addition to this primary differentiation of the cell, secondary differentiations occur, resulting in the production of organs such as chloroplasts, chromoplasts, leucoplasts, pyrenoids, and pigment spots, which have special

[1] Slightly abridged.

functions to perform. All these are permanent organs of the cell, produced in the first instance as a result of the cell activity, but now capable of an independent existence in the cell, in that they reproduce themselves by division, and are in this way carried on from cell to cell.

In many cells there are formed at certain stages other organs which appear to be transitory, and are only produced when they are required. Such are the spindle figure, the centrosome, the blepharoplast, and the cœnocentrum.

So far as we know, the cell is the smallest vital unit that can have a separate existence. But it is only among the unicellular organisms and under certain conditions in the earlier stages of development of the more highly organised multicellular organisms that cells have a perfectly independent life. Schwann's hypothesis that the multicellular body is a colony of independent vital activities governing the nutrition, growth, and reproduction of the whole is not tenable. The cell cannot be regarded as an independent unity working merely in association with other cells. Its life and existence depend upon these. It is an integral part of an individual organisation, and cannot exist apart from it. But this absolute dependence of individual cells upon the organisation as a whole is only realised in the more highly developed forms. In the lower types of plants (and animals) it is possible, during the early stages of development, to separate a single cell from the whole, which will still continue to live and grow. Each cell is no doubt dependent upon the others to some extent, even at this early stage, but it still retains the power to develop independently if placed under suitable conditions. As cell division continues each cell becomes more and more dependent upon its fellows, until the stage is reached when it no longer has the power to exist by itself. The various functions performed by a cell reside within it as an individual unit, but the exercise of these functions is governed by the organism as a whole. Just as the organism seeks for a state of equilibrium in relation to various external stimuli, so a cell in an organism has to adapt itself to and come into a state of equilibrium with the various cells around it.

The Nucleus.

The nucleus is the centre of activity, and governs the vital functions of the cell. All investigations show that in its absence the cell soon ceases to perform its vital functions and dies.

In all cells, from the algæ and fungi upwards, the nucleus is more or less clearly delimited from the cytoplasm by a membrane or limiting layer. The important substance which is thus separated off from the rest of the cell is the chromatin, probably the most complex and most highly differentiated chemical compound or collection of compounds in the cell. It exists in the form of a more or less granular network, and is characterised chemically by the presence of phosphorus, which is in organic connection with it. We may look upon the chromatin as the highest point in the development of living substance, upon which the activities of the cell in great measure depend, and as the seat of origin of all those complicated changes which have for their ultimate aim the division of the cell.

The division of the nucleus begins by a series of transformations in the chromatin network which lead to the differentiation in it of chromosomes. We know very little of what actually takes place during these changes, and practically nothing of the forces at work to bring them about. But the visible result is that the chromatin granules gradually fuse together, or become restricted to certain areas by the increased vacuolation of the ground substance of the nucleus to form a thick, more or less regular thread, in which can be observed at certain stages a differentiation into alternate regions of stainable and unstainable substance—chromatin and achromatin—which finally breaks up into equal or unequal lengths to form the chromosomes. In some cases the chromatin granules or network become aggregated into a definite number of irregular masses which form the chromosomes directly without the production of a distinct chromatin thread.

This nuclear differentiation is usually accompanied by changes in the cytoplasm which lead to the appearance of a fibrillar structure in the form of a more or less regular spindle, the threads of which come into contact with the chromosomes through the breaking down of the nuclear wall. The chromosomes then, by the action of a force or forces of which we as yet know very little, arrange themselves in regular order in the equatorial plane of the spindle figure, and some of the spindle fibres become attached to them. The chromosomes become divided longitudinally into two apparently exactly equal halves; and then, probably by the exertion of some sort of contractile force or pull on the part of the spindle fibres, the separate halves are caused to move to opposite poles of the spindle. Here a series of transformations take place, which lead to the constitution of two new nuclei. Such are the essential features in this complex process of nuclear division, and it is a striking fact that they occur with more or less regularity in all nuclei from the algæ and fungi up to the highest plants.

The Structure of Cytoplasm.

In the elucidation of cell structure we owe much to the beautiful methods of staining and fixing which are due especially to Flemming and Heidenhain, to the improved micro-chemical methods which we owe especially to Zacharias and Macallum, and to the investigations of such observers as Fischer and Mann, who have shown us the effects of various reagents upon the living substance, and have thus taught us to be very cautious in our interpretations of the structures seen in dead fixed cells.

The investigations of oil-foams and colloids by Butschli, Hardy, and others have given us a clue to possible explanations of the various appearances seen both in the living and dead fixed and stained cells, and the introduction of the ribbon section cutting microtome into the domain of vegetable histology has enabled us to make the best use of the beautiful apochromatic object-glasses which we owe to the researches of the late Prof. Abbe.

It is unfortunate that, so far, very little progress has been made in the examination of the structure of the living cell. We may hope that, with the improved methods of illumination now available, combined with experimental investigation, it will be possible to make some progress in this direction. It is of the greatest importance that we should be able to satisfy ourselves to what extent the various appearances seen in the fixed and stained cell are due to the action of the reagents employed. In this respect a recent discovery by Köhler, which indicates the possibility of making use of the ultra-violet rays in such investigations, is of interest. Köhler (*Phys. Zeit.*, 1904) finds that if the ultra-violet rays from the electric spark between cadmium or magnesium terminals are separated out by means of quartz prisms, objects illuminated by them, when examined by means of lenses made of quartz, show differentiations of structure which otherwise require staining to make them visible. The chromatin of the nucleus and such substances as cuticle and cork are almost opaque to the ultra-violet rays, and can be made visible on a fluorescent screen or can be photographed. The resolving power of the microscope is doubled, and Lummer considers that the principle employed is the only one by which further progress in resolving power can be made. If the method is found by cytologists to be a workable one, it may open up an entirely new field of microscopic investigation by which the protoplasmic differentiation in living cells may be more clearly revealed.

Many attempts have been made to show that the cytoplasm possesses a definite morphological structure of its own, which is related to the various functions it performs, and that it is not a formless semi-viscid fluid in which various physical and chemical forces are at work, and upon which the various structures observed depend; in other words, that it possesses a morphological constitution as opposed to a merely chemical one.

Fromman and Heitzmann in 1875 described the structure of cytoplasm as consisting of fine threads or fibres in the form of a net with fluid between and forming a sponge-like structure. Flemming in 1882 described it as composed of two substances, one in the form of fibrils (filar substance) embedded in the other, a more or less homogeneous interfilar substance. In 1890 Altmans propounded his interesting hypothesis that all living sub-

stance is made up of minute granules or bioblasts, which are the real vital units or elementary organism, embedded in a homogeneous substance, the non-living matter. Cells are formed by a combination of these units of a lower order, and are therefore individuals or units of the second order.

At about the same time Butschli brought forward his celebrated hypothesis of the froth or alveolar structure of cytoplasm. This was based upon an extensive series of observations upon both living and dead cells as well as upon froths or foams made by mixing salts of various kinds with oil and then placing small particles of the oily mixtures so obtained in water.

Butschli compares the structure of cytoplasm to that of a fine froth, and considers that much of the granular, and network or fibrillar structure can be referred to the optical appearances presented by such a froth. That such structures are visible cannot be doubted by anyone who has examined these froths attentively with the microscope. But that all the fibrillar structures described by Fromman and Flemming, whose observations have often been confirmed since by competent cytologists, can be referred to a froth structure, cannot, I think, be accepted by anyone who has carefully examined plant cells.

From the fact that cytoplasm appears homogeneous under certain conditions, and that the foam structure can be so readily produced in it by various means, and further that, as Hardy has shown, the action of certain reagents upon colloids results in the separation of solid particles which become linked together to form a comparatively coarse, solid framework in the form of an open net which holds fluid in its meshes, it is probable that we shall find the foam-structure theory of protoplasm is not tenable. It seems far more in accordance with what we know that we should regard protoplasm as fundamentally a semi-fluid, homogeneous mass, in which, by its own activity, granules, vacuoles, fibrils, &c., can be produced as secondary structures; and that any special morphological structure which it may possess is beyond the limits of the present resolving powers of the microscope.

The Structure of the Nucleus.

From the recent observations of Gregoire and Wygaerts, Berghs, Allen, Mano, and others, it is difficult to arrive at any definite conclusions as to the structure of the nucleus, or as to the changes which take place in it leading to the production of the chromosomes. The resting nucleus seems to possess a very simple organisation. In the living condition it appears to consist merely of a homogeneous ground substance in which is contained a mass of chromatin granules which do not appear to have any particular shape, and one larger granule of a spherical shape, the nucleolus. Sometimes a network or foam structure is visible, but not always; but here, as in the cytoplasm, it is difficult to be certain of this. It may be that the chromatin is always in the form of an irregular network embedded in the colourless ground substance, and that the granular appearance is due to an optical effect similar to that observed in finely meshed oil-foams. According to Strasburger, Miss Sargant, Farmer and Moore, Mottier, and others, the nucleus contains an achromatic network—the linin—in which the chromatin granules are embedded. Mano, Moll, and Sypkens deny the existence of these two substances, and state that the network consists of chromatin only; while Gregoire and Wygaerts, Allen and Berghs, are inclined to the view that there is a fundamental basis of linin which is impregnated by chromatin ordinarily diffused through its whole substance, but capable of being collected into certain definite regions under certain conditions by which the granular appearance is produced. The evidence brought forward in many of the more recent investigations certainly goes to show that the chromatin is not in the form of such definite granules as was at one time supposed; that they are not so regular in size or outline; and that it is not easy to differentiate between the chromatin and achromatin contents of the nucleus. Staining reactions do not afford a sound clue to their differentiation, for, as Fischer and, more recently, Allen have shown, the differences in staining reactions of the different parts of the nucleus vary according to the strength of the stain, the time it is allowed to act, and the size or thickness of the granules or threads stained.

Strasburger has suggested that the chromosomes are formed by the fusion of gamosomes (chromatin granules) around gamo-centres into zygosomes (chromosomes), but the changes which take place are probably not so clearly defined as this. What seems clear from the facts we know is that the substance forming the homogeneous chromosomes—the chromatin or nuclein—becomes broken up in the reconstitution of the daughter-nuclei, by vacuolation or otherwise, into an irregular network which presents a granular appearance. In this all trace of the original individual chromosomes is in most cases lost, and at the same time one or more deeply staining bodies of a spherical, or nearly spherical shape—the nucleoli—appear in contact with it.

The Nucleolus and its Function.

The evidence is steadily accumulating that the nucleolus is intimately concerned in the formation of the chromosomes, although probably not exclusively concerned in this function. In most cases it appears to form a part of the chromatin network, being connected to it by threads, and generally gives similar reactions to the chromosomes. In some few cases it is described as completely separated from the network by a clear area which is visible both in the living and in the stained condition. The evidence that the nucleolus is concerned in chromosome formation may be summed up as follows: the nucleoli are closely connected or associated with the nuclear network; as the nuclear network becomes more deeply stained the nucleoli become smaller or lose their capacity for stains; at the time the chromosomes are being differentiated they are connected to the nucleoli by delicate threads; the chromosomes resemble nucleoli in their behaviour towards reagents and stains; during the period of sinapsis the nucleoli come into very close relations with the nuclear thread, and as the nucleus gradually passes out of the sinaptic stage the thread stains more deeply; in the reconstitution of the daughter-nuclei the chromosomes can be seen to fuse together into a more or less irregular mass, out of which the delicate nuclear network and the prominent nucleolus are evolved; in certain cases all the chromatin appears to be stored up in the nucleolus.

It has been suggested that the nucleolar substance is a product of excretion of the nucleolus, but there is very little evidence for this view. On the other hand it is very likely, as suggested by Mottier, that the nucleolus contains a store of nutritive material which can be used up for various purposes, both in the nucleus and in the cytoplasm. In some cells a portion of the nucleolar substance is thrown out into the cytoplasm during the division stages, and it is very probable that this may have some important connection with the metabolic activity of the cell at this period.

Division of the Nucleus in the Spore Mother-cells.

The divisions of the nucleus which lead immediately to the formation of the spores possess some features which are not found in ordinary vegetative mitosis, and which have an important bearing upon the facts of heredity. The first of these is known as the heterotype, the second as the homotype division. The essential features of the heterotypical division are as follows:—The chromatin net becomes gradually resolved into a more or less continuous spireme. This thread (or threads) contracts into an irregular mass around the nucleolus, a phenomenon which was first discovered by Moore, and to which he gave the name of "sinapsis." Some observers regard this contraction as caused by reagents; but since it has been observed in the living condition by Miss Sargant and others, it is probably a definite and normal stage in the division. It is concerned with some very pronounced changes which take place at this time in the nucleus. The nuclear thread becomes more prominent, stains more deeply and exhibits a double row of granules which gives it the appearance of a double thread. This has been variously interpreted by different investigators: Miss Sargant, Farmer and Moore, and many others consider that it is due to a longitudinal splitting of the thread; Dixon, Gregoire, Berghs, and Allen consider it as indicating a close approximation of separate loops of the

thread. Whichever of these explanations is the correct one, the doubling gradually disappears and the thread becomes distributed through the nuclear cavity and again appears single; it becomes shorter and thicker and once more becomes aggregated around the nucleolus. This may be, as Miss Sargant suggests, a second sinapsis. At this stage the chromosomes appear, but reduced to half the number of those which appeared in the previous divisions, so that they may be regarded as bivalent or double chromosomes. They become shorter and thicker, and gradually become grouped in the equatorial plane of the nucleus, where they become attached to the spindle fibres. Each chromosome now divides into two halves, which pass to the respective poles of the spindle, to form, without the intervention of a complete resting stage, the division figures of the daughter-nuclei.

The exact mode in which the division of the chromosomes into two halves takes place is the subject of much controversy. The studies of Weissman on the phenomena of heredity led him to the conclusion that the chromosomes consist of more than one complete ancestral germ-plasm, and that consequently these must be reduced in number in the sexual cells to escape the extraordinary complexity which would arise if the ancestral germ-plasms were doubled at each sexual fusion. As the longitudinal division of the chromosomes divides them into two equal halves it is obvious that this will not reduce the number of ancestral germ-plasms, and therefore Weissman predicted that a transverse division of the chromosomes would be found to take place by which the reduction would be brought about. This was soon discovered to be the case for many animal cells, the reducing division taking place during the formation of the sexual cells, but in plants this was not so easily determined. Belajeff, Dixon, Atkinson, and others maintained that a true reduction division took place in the cases examined by them; but the majority of observers, Miss Ethel Sargant, Strasburger, Farmer, Mottier, and many others, maintained that there was no transverse division, but that all the divisions were longitudinal. Recently, however, Farmer and Moore have re-investigated the whole sequence of events in both animals and plants, with the result that a true reduction division is found to occur in the heterotype stage. In many investigations which have recently appeared this transverse division is confirmed, but the exact details of the process are not yet agreed upon. Farmer and Moore state that the spireme thread first becomes longitudinally split, the two longitudinal halves then fuse again, and subsequently bivalent chromosome loops are formed which divide transversely in the middle, and so produce two monovalent chromosomes which pass to opposite poles of the spindle, as already described. Gregoire, on the other hand, states that the threads at the first sinapsis become approximated together and then fuse; the double thread thus produced breaks up into chromosomes, which are thus bivalent in a different sense from those of Farmer and Moore, the monovalent chromosomes being produced by a longitudinal splitting of the thread, which divides it into the two original halves which fused together.

Which of these two methods will ultimately be found to be the correct one remains to be seen, but Allen has recently published an account of the process as it occurs in *Lilium canadense*, in which he agrees substantially with Gregoire, and states definitely that the first appearance of the double nature of the thread is not due to a longitudinal splitting of a single thread, but to an approximation of two threads, which ultimately fuse together to form a single continuous thread in the nuclear cavity. This thread at a later stage undergoes a longitudinal splitting, possibly into those which formerly united; but this is not certain. The double thread then divides up into segments, the chromosomes, and in the subsequent series of events the longitudinal halves of these chromosomes become distributed to the opposite poles of the spindle. Each chromosome is thus seen to be bivalent; but whether each half of the chromosome is to be regarded as a monovalent chromosome is doubtful, as the fusion of the original threads was complete, and there is no means of deciding as to how far the subsequent longitudinal division of the completely fused thread separated it into its two original parts.

Sinapsis.

The term "sinapsis" was first given by Moore to that stage in the prophases of the nuclear division of the sexual cells in which the contraction of the nuclear thread around the nucleolus at one side of the cavity of the nucleus takes place. If this phenomenon is not a result of the action of the fixing reagents, then it indicates some striking change in the metabolic activity of the nucleus. This activity is seen in the increased staining capacity of the chromatin thread and in the changes which take place in the nucleolus, by which it becomes very irregular in shape and closely connected by threads to the chromatin network. In many cases the nucleolar substance appears as if being drawn out into the threadwork, and the nucleolus appears as if some active change were taking place in it.

It is very difficult to escape the conclusion that we are here dealing with a series of changes in the chromatin thread which are intimately bound up with the activity of the nucleolus, and it is probable that the increased stainability of the chromatin is due to an actual transference of a portion of the nucleolar substance into the thread.

Experimental Observations on the Activities of the Nucleus.

So far as I know no experimental investigations into the causes which bring about the changes in the prophases of nuclear division have been made, but it is not difficult to imitate artificially some of the phenomena observed. Olive oil is shaken up in a mixture of methylated spirit and water of such a strength as will allow the oil globules to float. A shallow Petrie dish, three or four inches in diameter, is then taken; the mixture of oil and dilute methylated spirit is well shaken until the oil is broken up into very fine globules, and the mixture is at once poured gently into it. The appearance of the mixture is that of a homogeneous mass of small oil globules distributed through the solution, and can be compared to the granular appearance of a nucleus in a resting stage. The spirit at once begins to evaporate, and currents are at once set up in the solution in such a way that the globules of oil gradually become restricted to certain areas only, and a coarse granular network is formed somewhat like the early stages in the aggregation of the chromatin granules into a spireme in the nucleus. The network gradually becomes more and more clearly defined, and then, just as is the case in the nuclear network, it begins to show a double row of granules, which finally becomes very clear and distinct. The threads become shorter and thicker and break up into irregular lengths, which gradually mass themselves together into an irregular heap or heaps of fusing-oil globules either in the middle or at the periphery of the petrie dish. We have, in fact, a good imitation of the earlier stages in the prophases of division of the nucleus, and it seems not unlikely that the aggregation of oil globules in our petrie dish may afford some clue as to the possible means by which the aggregation is brought about in the nucleus.

I do not suggest that the complex phenomena which take place in nuclear division are to be explained as due simply to such phenomena as diffusion, surface tension, and the like, or any other physico-chemical processes. We must be very careful not to attempt to force merely physico-chemical explanations upon such phenomena as these. Without admitting the necessity of anything akin to a special vital force, we are compelled to admit that vital phenomena do not at present admit of a merely mechanical explanation. But it does seem to me possible that the metabolic activity of the nuclear material at this stage may be accompanied by phenomena referable in part to these agencies. If, for example, active metabolic activities are set up between the nucleus and cytoplasm through the nuclear membrane, as seems probable, it is quite conceivable that this would bring about diffusion currents which might be taken advantage of in producing the aggregation of the more solid parts of the nuclear substance into a more or less definite thread-like structure and its aggregation into chromosomes. In any case such possibilities must be taken into account in considering

the significance of such nuclear re-arrangements, and if any of them can be definitely explained in this way the final solution of the problem may be much simplified.

Validity of Cell Structure as seen in Fixed and Stained Preparations.

Our knowledge of the minute details of cell structure and nuclear differentiation depends upon the appearances presented by cells which have been fixed in various reagents and subsequently stained, and it is not an easy matter to determine in how far these are artificial and in how far they are actual structures existing in the living cell. The researches of Fischer, Hardy, Mann, and others have shown that on the precipitation of proteids by reagents structures are produced which were certainly not present originally, and which resemble those often observed in fixed cells. From a consideration of such facts it has been suggested that many of the details revealed in fixed cells, such as centrosomes and centrospheres, with their fibrillar radiations, are produced artificially and have no real existence. It is unfortunate that so little attention has been paid to the examination of living cells, for the structures which can be seen in them are, so far as they can be revealed by the microscope, always like those seen in fixed preparations.

Differentiation of Structure Visible in the Living Cell.

The amount of differentiation visible in the living cell in favourable objects is very considerable. Not only can chloroplasts, starch-grains, nucleus, leucoplasts, pyrenoids, &c., be clearly seen, but also a very considerable amount of detailed structure. Chromosomes have been seen in the living cell by many observers—Treub, Strasburger, Behrens, Zacharias, and others. The series of figures published by Strasburger of nuclear division in the staminal hairs of Tradescantia show the whole process of chromosome formation and separation into two daughter-groups, except the longitudinal division.

In the same object Demoor and de Wildeman have also been able to detect the spindle fibres and connecting fibres. These were not seen by Strasburger; and Zacharias, who has more recently made observations on staminal hairs, was also not able to detect them. Nevertheless Strasburger mentions that in some cases connecting threads were visible at a late stage in the division between the daughter-nuclei, and Treub also describes a similar phenomenon in some cases during the nuclear division in the ovules of an orchid.

In Spirogyra, Strasburger has given a full account of nuclear division in the living cell. Large species of this alga are very favourable objects for this work, and he has shown that in such species the spindle figure as well as the connecting fibres can be seen in the living cell. Wildeman has also seen and figured them; but Behrens states that spindle fibres and connecting threads are not visible in Spirogyra during life.

My own observations upon a large species of Spirogyra which I have had an opportunity of investigating entirely support the view that these structures are visible in the living condition.

The Structure of the Chloroplast.

In view of its extreme importance in the function of assimilation a knowledge of the structure of the chloroplast is important. Owing to its small size a satisfactory demonstration of its finer structure is very difficult. That it consists of a colourless ground substance, in which the chlorophyll is embedded, is clear; but how these two substances are united and the relations between them structurally are not known. Pringsheim concluded that the ground substance of the chloroplast is a sponge-like network with the oil-like solution of chlorophyll in its meshes.

Schmitz thought that the fine granular appearance of the chloroplast was due to a fine net-like structure in which the chlorophyll was diffused. Fromman also describes it as a green granular network. Schwartz, on the other hand, describes it as composed of a ground substance containing a number of green fibrillæ side by side, which are coloured green throughout, but show also an accumulation of the green colouring matter in the form of granules along these threads.

Meyer thought it was composed of a homogeneous ground substance with various-sized granules of the green substance embedded in it. To these granules he gave the name of "grana." Schimper stated that it was composed of a colourless stroma containing numerous vacuoles filled with the green semi-fluid chlorophyll, identical with the "grana" of Meyer.

Some observers consider that the chloroplast is surrounded by a distinct membrane; whilst others consider that the substance of the chloroplast is directly connected by colourless strands to the cytoplasm.

According to some observations which I have made recently, the chloroplast, when examined under high powers in the living condition, appears to be filled with a mass of green granules with a colourless substance between them. But in certain cases a distinct fibrillar arrangement of the chlorophyll is observed. This is very easily seen in the chloroplasts of Euglena, both in the living condition, and, more easily, when the cells are burst and the chlorophyll grains are extruded into the water. But it may be seen also in the chloroplasts of the higher plants when these are large enough to be examined easily. In these cases the green colouring matter appears granular when the chloroplast is in the epistrophe or shade position, fibrillar when it is in the apostrophe or intense light position. This difference in the appearance of the chlorophyll accompanies a difference in the shape of the chloroplast. As is well known, the chloroplast in the epistrophe position presents an oval or more or less circular form; in the apostrophe position a flattened and lenticular form. The fibrillar structure appears to be that of fine fibrils lying more or less parallel, but a closer examination shows that they are connected together here and there so as to give the impression of an elongate network. In the epistrophe condition the chlorophyll corpuscle appears greener than in the apostrophe condition. The granules are in fact so arranged and so numerous as to present a practically continuous surface of chlorophyll to the action of the light rays. The fibrillar arrangement, on the contrary, has numerous light spaces between the fibrils, so that less surface of chlorophyll is exposed to the rays of light. The difference in the amount of chlorophyll surface exposed to the light appears therefore to be bound up with the difference in the intensity of light which causes the different positions of epistrophe and apostrophe to be assumed by the chloroplast. Just as in diffuse light the chloroplasts themselves are more fully exposed to the light than in intense light, so in the individual chloroplast we appear to have such an arrangement of the chlorophyll that in diffuse light a larger surface of it is exposed to the light rays than in a more intense light. The interesting conclusion is therefore arrived at, that the chloroplast is able, not only by its position but also by its structure, to guard itself against the effects of a too intense light.

A careful examination of the chloroplast in the epistrophe position renders it probable that the granular appearance is not due to the existence of separate granules of chlorophyll. It resembles more nearly an optical effect, due to the superposition of alveoli upon one another, such as appears in fine oil-foams. By focusing carefully above and below the granules we get a distinct appearance as of a green alveolar network. If the chlorophyll corpuscle is extruded into water it begins to swell up and becomes vacuolar; the granules disappear and the chlorophyll then appears to be distinctly diffused through the ground substance of the chloroplast. I am therefore inclined to the view that the chlorophyll corpuscle consists of a ground substance in the form of a delicate alveolate structure, in which the chlorophyll is more or less uniformly diffused. The diameter of the threads of this network is greater in the epistrophe than in the apostrophe position, and this affords a means by which the chloroplast can accommodate itself to varying intensities of light.

The chloroplast must be regarded as performing at least two functions. It brings about the dissociation of CO_2 and it is a starch-forming organ. In the algæ and some other plants these two functions appear to be differentiated, and starch is formed directly by the pyrenoid. How far these two functions are independent in the ordinary chloro-

plast is not known; but that starch can be formed, independently of chlorophyll, in the leucoplasts and in the ordinary chloroplasts directly from sugar and other organic solutions in the dark seems to indicate that the two are not necessarily connected.

The colourless stroma of the chloroplast gives a distinct and pronounced reaction for phosphorus when treated according to Macallum's method. It resembles, therefore, in this respect the nuclein constituent of the nucleus. What the exact significance of the presence of phosphorus in the chloroplast may be I do not know, but it is extremely interesting to find that in an organ in which a high degree of metabolic activity is always found a substance should be present which is akin to the highly organised nuclear constituents. It suggests an interesting comparison with those plants in which a special starch-forming organ, the pyrenoid, is differentiated.

The Centrosomes and Centrospheres.

A vast literature has grown up in connection with the structure and function of these bodies because of the special importance which has been attached to them as the originators of the process of nuclear division and of the formation of the spindle, and because of the important part which it is assumed they play in the phenomena of fertilisation.

Their very general occurrence in animal cells and their prominence in the reproductive processes led plant cytologists to predict that they would be found to occur also in plant cells. But their prediction has not been fulfilled. They are frequently found among the Thallophytes and Bryophytes, but in the higher plants the evidence is steadily accumulating against them, and such structures as have been described by Guignard and others are held to be based upon a misinterpretation of the facts observed.

Where the centrosome exists it consists of a deeply stained granule or group of granules surrounded by radiating fibres. In some cases, as in the Basidiomycetes, the centrosomes only become definitely visible as minute dots at the poles of the spindle, and are not visible until this is completely or nearly completely formed. In other cases, as in Dictyota (Mottier), Ascomycetes (Harper), the centrosomes with their radiations are clearly visible at two opposite sides of the nucleus in the resting stage, and are in close contact with the nuclear membrane. In the Ascus, Harper has shown that the centrosome is in close contact, not only with the nuclear membrane, but also with the chromatin net, and it seems probable that there may be a connection between them. The spindle fibres are formed both in Dictyota and in the Ascus in the nuclear cavity before the nuclear wall breaks down. In the division of the daughter-nuclei the centrosome which is carried over with each daughter-nucleus appears to divide—but this is not certain—to give two new centrosomes for the formation of the new spindle figure.

Experiments on the Production of Artificial Asters.

There are two main views as to the nature of the spindle and astral fibres: (1) that they represent a definite morphological differentiation of the cytoplasm which possesses in itself the power of forming these fibres; (2) that they are formed out of the cytoplasm by some modification of its structure or arrangement of its parts, or by the precipitation or condensation of some of its constituents.

The aggregation of granules into radiating fibrils can be imitated artificially by allowing a drop of alcohol or turpentine to fall upon smoked glass. If the drop is allowed to fall from a good height, we get the artificial centrosomes with radiations first described by Henking; these are due mainly to the splash of the drop and its breaking-up into small particles which radiate outwards, carrying portions of the smoke film with them. If the drop is allowed to fall more gently, so that it does not splash, its first effect is to produce a clearly circumscribed circular ring, and then, by slowly spreading outwards, to produce an aggregation of the smoke particles into fibrils which more nearly represent the appearances produced in cytoplasm than do Henking's splashes.

By careful manipulation we can get in this way representations of the centrosome or centrosphere, or even the radiations around the nucleus. If the edge of the alcohol or turpentine be carefully examined under the microscope as it is slowly spreading outwards, a violent motion of the smoke particles will be observed as soon as the liquid comes into contact with them, and as the liquid passes on these particles settle down into definite continuous fibrils, which go on growing as the liquid continues to spread.

Fischer has described the formation of artificial asters by two methods: (1) If pith is injected with proteid and then fixed, asters are found around small particles of foreign matter in the proteid. (2) If a small granule of corrosive sublimate or a drop of osmic acid be brought into a proteid solution radiating striæ are formed in it by precipitation. He suggests that the centrosome is formed by the precipitation of albuminous substances in living cells by the excretion of nucleic acid from the nucleus, and that, as in (1), artificial radiations are formed around it by the action of the fixing reagents; or possibly by the fixative action of the nucleic acid itself. Or the centrosome itself may produce them, as in (2), by acting as the precipitating agent, just as corrosive sublimate or osmic acid. Mr. Jenkinson has recently described some interesting experiments on the artificial production of asters, and comes to the conclusion that osmotic pressure and surface tension are probably concerned in the formation of these structures in the living cell. The centrosome may be a body capable of withdrawing water from the cytoplasm, of swelling up and dissolving in the water so absorbed, and then giving off radial outgrowths which precipitate the proteids of the cell, and so form astral rays; or the centrosome may undergo decomposition, or may secrete a ferment which would have the same effect upon the cytoplasm.

The Blepharoplast.

The blepharoplast is a special organ associated with the formation of the cilia in motile spermatozoids and zoospores. It consists of a centrosome-like granule, often surrounded by radiations. It appears inside the cell in close relation to the nucleus, or sometimes at the periphery of the cell. In Polytoma the two cilia thus arise from a granule (blepharoplast) at the extremity of the cell. In Ædogonium the blepharoplast arises, according to Strasburger, in the plasma membrane. Strasburger considers them as kinoplasmic in nature, and thus brings them into relation with his other kinoplasmic structures, the centrosome and spindle.

Some authors consider that the blepharoplast is a true centrosome, or homologous with a centrosome. It has not, however, been conclusively shown that it at any period in its history performs the function of a centrosome, or that it is derived from one. Further, in many of these plants, if not all, there are no centrosomes at any stage in their life-history.

On the whole the evidence is distinctly against the view that the blepharoplast is genetically connected with the centrosome. It is more in accordance with the present state of our knowledge to consider the blepharoplasts as special structures which arise *de novo* in the cell for the special function of cilia formation.

The Coenocentrum and its Function.

In the oögonia of some fungi there appears at an early stage in the development of the oösphere a dense granular, deeply stainable substance, the function of which is unknown. It appears in the centre of the cell, and was first discovered in the oösphere of *Cystopus* (*Albugo*) *candida*. It is probably formed by an accumulation of stainable granules or microsomes. It disappears soon after fertilisation takes place, and is therefore not a permanent organ of the cell. Shortly after its appearance one of the nuclei out of the large number irregularly scattered through the oögonium comes into contact with it, and gradually becomes more or less embedded in it. All the other nuclei pass to the periplasm, leaving this single nucleus as the nucleus of the ovum. The fertilising tube which contains the male nucleus also grows towards it, and comes close to it to discharge the male nucleus upon it. This indicates that it may exert in some way or other an attraction, first upon the female nucleus, and secondly

upon the fertilising tube, thus helping to bring the sexual nuclei together. Stevens suggests that it may be of the nature of a dynamic centre, and he gave it the name *coenocentrum*. It may be nutritive in function, and may exert a chemotactic stimulus upon the sexual nuclei.

It does not appear to be actually concerned in the fusion of the sexual nuclei. In *Peronospora parasitica*, for example, it completely disappears before the fusion of the nuclei takes place. So far all the views as to its function are purely hypothetical. It may be a mere coincidence that it should become associated with the sexual nuclei at the time they come together in the oösphere. Its function may be totally unconnected with these. From the fact that it stains so deeply in nuclear stains, the substance of which it is composed may be of the nature of nuclein, and it is possible that it may be due to a substance secreted by the nuclei of the oögonium for some special purpose connected with the maturation of the oöspore. It is possible that it may have something to do with the formation of oil, which appears in such abundance in the ripe oöspores. It begins to disappear just at the time the oil begins to form.

It seems more likely that the function of the cœnocentrum is connected with those metabolic activities of the zygote, which must at this stage in its development be very considerable, than with the exertion of an attractive influence upon the sexual nuclei. It is difficult to see how such a selective chemotactic stimulus could be exerted as to act upon one nucleus only out of the large number in the oögonium. But the evidence before us does not admit of any definite solution of the problem at present. The subject demands further investigation of such a kind that a comparative study of the formation and disappearance of the cœnocentrum, the formation of the oil reserves, and the changes in the nuclei, should be carried on side by side.

The Nuclei of the Lower Plants.

The presence of nuclei in the algæ and fungi had already been recorded by Nägeli and many other observers shortly after the discovery of the nucleus by Robert Brown, but it is doubtful whether all the structures described as nuclei by these early observers were really so. It is only in comparatively recent times that it has been possible to determine with any degree of certainty that the minute deeply stainable bodies described more especially by Schmitz (1879) could be regarded as nuclei. This determination was easily made for many of the algæ, especially by the researches of Strasburger, who described both the structure and mode of division. But among the fungi the structure and mode of division of the nuclei were practically unknown twenty years ago, and we have the opinion expressed by De Bary in 1887 that the satisfactory discrimination of true nuclei from other small bodies contained in the protoplasm can only be obtained after renewed investigation.

Previous to 1887 cases of karyokinetic division in fungi had been described by Sadebeck (1883), Strasburger (1884), Fisch (1885), and Eidam (1887). Hartog (1889) described a process akin to karyokinesis in the Saprolegnieæ, and at the end of that year a true process of karyokinesis was shown to occur in Peronospora. Since that time our knowledge of the process of nuclear division in the fungi has been largely extended, and the phenomenon has now been found to be of general occurrence in the group, and many of the forms are unusually favourable objects for the study of the process.

The only groups of plants in which true nuclei have not been found are, so far as I know, the bacteria, Cyanophyceæ, and the yeast fungi. In the yeast plant there is a large homogeneous spherical body which gives the reactions of chromatin similar to the chromatin of true nuclei. With this is associated a prominent vacuole which contains a more or less amorphous substance of a chromatin nature. The two appear to be very closely related and undergo division simultaneously.

The Cell Structure of the Cyanophyceae.

It is easy to demonstrate in the living cell of the Cyanophyceæ that the contents are differentiated into two distinct regions: (1) an outer layer containing the colouring matter; and (2) a central colourless portion which is known as the central body. The central body is considered by many investigators to be a true nucleus. It contains a deeply staining granular substance which to some extent resists the action of digestive fluids, and is therefore similar to the chromatin in the nuclei of the higher plants. In 1887 Scott was able to demonstrate a reticulate structure in this body, and also saw some indications during its division of a process akin to karyokinesis. Zacharias also in the same year, largely on micro-chemical grounds, concluded that it was a nucleus. The problem has been the subject of investigation by numerous observers since that date with very varying results. These results may be shortly summarised as follows:—The central body is not a nucleus (Macallum, Fischer, Massart, Chodat). It is a nucleus of a simple or rudimentary type (Hieronymus, Nadson, Butschli). It is a true nucleus similar to that found in the higher plants, and forms both chromosomes and spindle (Hegler, Kohl, Olive, Phillips).

The facts of the structure of this body, so far as I have been able to ascertain them by the examination of the cell both in the living and fixed conditions, are that it possesses a vacuolate structure, associated with granules which stain deeply in nuclear stains, resist the action of digestive fluids, give a strong reaction for phosphorus and masked iron, and, further, according to the recent researches of Macallum, do not contain potassium. These qualities are characteristic of nuclein, and there can be, I think, no reasonable doubt that these granules are comparable to the chromatin of a true nucleus.

From a consideration of the facts we at present know concerning the central body we cannot, I think, escape the conclusion that it is of the nature of a nucleus, but one of a simple or rudimentary type. It is not sharply delimited from the surrounding cytoplasm, although it sometimes appears as a vacuolar cavity in the centre of the cell, with a vacuolar membrane around it. It seems to me that we might very well regard it simply as a specialised region of the cytoplasm which possesses a pronounced vacuolation associated with granules of chromatin or with a chromatin network.

The Function of the Nucleus of the Cyanophyceae.

The nucleus of the Cyanophyceæ is very large, much larger proportionally than the nuclei of the higher algæ. It gives also a proportionally stronger reaction for phosphorus. Some observers have considered the large size and prominence of the central body as an argument against its nuclear nature. In the algæ the nuclei are much smaller in proportion to the cell, and in many forms are very difficult to make out. On the other hand the pyrenoids which are present in the cells of Algæ stain more deeply in the nuclear stains, and give a much stronger reaction for phosphorus than the nuclei. In *Prassiola parietina* the pyrenoid is in the centre of the cell, and both in the living condition and in stained preparations is much more prominent than the slightly stained nucleus on one side of it. So, also, in Zygnema there are two star-shaped chromatophores, each with a large pyrenoid in the middle, and between them a small very inconspicuous nucleus.

My view is that the large size of the central body in the Cyanophyceæ may be connected with the development of the chlorophyll assimilation; that it may be held to function both as a pyrenoid as well as a nucleus, and that this receives support from what is observed in the coloured bacteria, in which the cytoplasm contains a more abundant supply of chromatin granules than do the colourless bacteria.

Structure of the Bacterial Cell.

Owing to the small size of the bacterial cells it is very difficult to arrive at a correct interpretation of the structures observed. The examination of the larger forms, such as the various species of Beggiatoa, Chromatium, *Bacillus anthracis, Bacillus subtilis,* &c., has, however, revealed a certain differentiation, which enables us to come to some conclusions as to their actual structure. Ernst has shown that the contents of these cells are not homogeneous, as was formerly thought to be the case, but show a differentiation into a less stainable substance, and embedded in it one or more deeply stained granules.

Butschli has shown that the central portion of the contents of the cell exhibit a foam structure in which granules of a chromatin nature are embedded: this is surrounded by a thin layer of a less deeply stained substance, which sometimes accumulates more prominently at the ends of the cell. The central, more deeply stained, froth-like structure with its granules is the nucleus; the delicate peripheral layer is the cytoplasm. From a recent examination which I have made of *Beggiatoa alba, Beggiatoa roseo-persicina, Bacillus subtilis,* and other smaller species, I cannot agree with Butschli that there is a differentiation into a central body or nucleus, and peripheral cytoplasm. In the various species of Beggiatoa and Spirilla which I have examined the cell contents exhibit a reticulate or foam structure of the cytoplasm in which one or more deeply stained granules may be embedded. As these granules stain deeply in nuclear stains, and also give a reaction for phosphorus, they are probably similar to chromatin. They are distributed throughout the whole cell, and are not specially confined to one place.

We must conclude that the bacteria do not contain anything which can be individualised as a nucleus, but that the nuclein constituent of the cell when present is contained in granules distributed throughout the cytoplasm.

The Evolution of the Nucleus.

All plant nuclei, from the algæ and fungi upwards, present a striking similarity both in structure and mode of division. The same appears to be true of the animal kingdom, from the protozoa upwards. But among the protozoa on the animal side, and the yeast fungi, bacteria, and Cyanophyceæ on the plant side, there is a kind of border kingdom in which occur structures which appear to represent the nuclei of the higher organisms, but are so different from them in many respects that it is very difficult to say whether they should be regarded as nuclei or not. As we have already seen, the central body of the Cyanophyceæ and the chromatin granules of the yeast plant and bacteria may represent simple or rudimentary forms of nuclei. It is, therefore, possible that we may obtain from them a clue or indication of some kind as to the origin of the nucleus and the process of its evolution.

It is among the protozoa that we find the greatest variation both in form and structure of these rudimentary nuclei. All the various parts of the nuclei of the higher animals can be recognised in them, but, as Calkins points out, are rarely present in one and the same nucleus. From a consideration of the various types Calkins considers that the most primitive nucleus is probably a single mass of chromatin without membrane or reticulum. By the division of this into granules, their association into lines forming primitive chromosomes, the development of a linin network, and the formation of a definite nuclear membrane was gradually brought about the development of the typical nucleus.

In the three groups of plants the Cyanophyceæ, bacteria, and yeast fungi it is not possible to recognise all the various parts of typical nuclei as in the protozoa. In none of them do we find a nuclear membrane, nucleolus, chromosomes, or spindle figure, or centrosome. We have nothing very tangible, therefore, to compare with the typical nucleus of the higher plants, and it is no doubt very largely due to this that we have so many contradictory accounts of the nuclear structures in these forms.

At the same time the nuclei of the higher plants pass through stages in their division which more nearly approach in their structure the simple forms with which we are now concerned. Thus the nuclear membrane and nucleolus disappear, and the chromatin network becomes condensed into a number of homogeneous rods or granules, the chromosomes, which lie free in the cytoplasm. There seems to be no reason why we should not consider the simpler chromatin structures in the lower plants in the light of these ontogenetic changes, as we may term them, of typical nuclei, in order to obtain some indication of the origin and phylogenetic development of the nucleus.

We may take the colourless Beggiatoa as a starting-point; not that this form is the lowest, but because its structure is, on account of its size, more easily examined, and because it is connected possibly with the Cyanophyceæ on the one hand and with the ordinary bacteria on the other. From a careful examination and comparison of its structure with that of other low forms we obtain the following diagram, showing their possible relationships as indicated by their cytological structure:—

?

Beggiatoa alba.
(Chromatin granules may or may not be present.)

Beggiatoa roseo-persicina, Chromatium okenii, &c.
Many chromatin granules often condensed in the centre of the cell. Cytoplasm coloured.

Cyanophyceae.
Central body with chromatin granules surrounded by a peripheral coloured protoplasm.

?

Algæ.

Larger Spirilla with colourless cytoplasm. (Few small chromatin granules).

Forms like *Cholera vibrio, B. lineola, B. anthracis, Typhus bacillus,* &c. Colourless. (One or two chromatin granules.)

Yeast Fungi.
With one or two chromatin granules associated with a nutritive vacuole.

Fungi.

In the simplest case the cell of Beggiatoa contains only cytoplasm without, so far as I can see by careful examination with the highest powers available, any differentiation of chromatin grains or structures of a like nature. Neither do I think that we can regard the protoplast as representing a nucleus. As Fischer points out, the idea that the protoplast of the bacteria stains like a nucleus is not correct, and, as I have been able to show, it certainly does not give a phosphorus reaction like a nucleus. It is, in fact, a simple undifferentiated mass of cytoplasm, either homogeneous or at times exhibiting a foam structure. In this cytoplasm a few granules of chromatin may become differentiated, and this is the first indication of the separation of nuclear substance. Whether there are any species of Beggiatoa or other bacteria which are permanently without nuclear granules I do not know, and it will be very difficult to prove it: but the fact that under certain conditions these cells exist without them seems to point to the conclusion that this may be the primary cell structure, as has been surmised by Haeckel and others.

At an early stage in the evolutionary history of the protoplasm, before a typical nucleus was evolved, we appear to have had the development of colouring matter for the function of assimilation, and a bifurcation into the two distinct lines of descent of the fungi and the algæ. This appears to have been accompanied by two distinct lines of nuclear evolution leading respectively to the development of the central body of the Cyanophyceæ and the nuclear apparatus of the yeast plant. The possible lines of development of the nucleus up to the yeast fungi on the one side and to the Cyanophyceæ on the other are clearly indicated in the diagram; but between the yeast fungi and the true fungi, and between the Cyanophyceæ and the Algæ, there are gaps which we cannot bridge at present. It is possible that the evolution of the typical nucleus may have been brought about in the fungi by the more definite association of the nuclear vacuole with the homogeneous nuclear body, possibly accompanied by a vacuolation of the latter, or that the nuclear body itself

may have become the nucleus direct by a process of vacuolation and differentiation within itself.

In the case of the Cyanophyceæ I have already shown that the central body is a vacuolar structure associated with granules of chromatin, and that sometimes this vacuolation becomes so pronounced in resting cells that we get an appearance as of a limiting membrane between it and the cytoplasm. The granules run together and become associated in such a way as to simulate the spireme thread of an ordinary nucleus. Further, we have in some Cyanophyceæ a differentiation of a nuclein-like substance in the form of the red granules of Butschli at the periphery of the central body, which may be an early stage in the separation of a portion of its substance to perform the special functions of the pyrenoid. The complete separation of this into a definite pyrenoid and the formation around the remainder of a nuclear membrane would give us a differentiation comparable to some extent to what we find in *Euglena viridis,* where we have a reticulate nucleus which divides by a rudimentary process of karyokinesis, in which, so far as we know, there is no definite formation of chromosomes and no longitudinal splitting.

As to when or how the higher differentiation of the nucleus, with its chromosomes, longitudinal division, and spindle figure, arose we do not know. Possibly a careful investigation of the lower forms of the fungi and algæ and such organisms as Euglena, and especially the protozoa, may throw light upon this difficult problem.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SIR DONALD CURRIE has promised to give 20,000*l.* to the equipment fund of Queen's College, Belfast, provided an equal sum is raised from other sources. It is understood that a considerable portion of this amount has already been promised.

MR. E. TOWYN JONES, demonstrator in chemistry at University College, Bangor, has been appointed assistant lecturer and senior demonstrator in the department of chemistry and physics of the Pharmaceutical Society of Great Britain.

IT is announced that Mr. Bazil McCrea has given 6000*l.* to found a chair of experimental physics in Magee College, Londonderry, and to provide two scholarships in connection therewith. The gift is conditional upon funds being provided by subscription within six weeks for the erection of a suitable physical laboratory.

WE have received the year-book of the Michigan School of Mines for 1904–5, and an album of views showing the facilities for instruction afforded by the immediate surroundings of the college. Established in 1885, the college is situated at Houghton, in the heart of the great copper mining region of Lake Superior, with the deepest shafts in the world and the most powerful machinery ever employed in mining. The students also have access to the docks, railways, dressing plants, and smelting works. The special facilities for practical training largely account for the success which the institution has attained. There are at the present time 223 students, their average age being 22½ years.

THE metropolitan medical schools will re-open for the winter session on October 2 and October 3, and in many of them inaugural addresses will be delivered. At University College the address will be given on October 2, at 4 p.m., by Prof. Kenwood on "Preventive Medicine: Past and Present"; at King's College on October 3, at 3 p.m., by Prof. Clifford Allbutt, F.R.S., on "Medical Education in London," and an opening lecture on October 4, at 4 p.m., by Prof. Dendy on "The Study of Zoology"; at Charing Cross Hospital on October 2, at 4 p.m., by Sir James Crichton-Browne, F.R.S.; at St. George's Hospital on October 2, at 3 p.m., by Mr. Brudenell Carter; at the Middlesex Hospital on October 2, at 3 p.m., by Dr. R. A. Young; at St. Mary's Hospital on October 2, at 3.30 p.m., by Dr. Wilfred Harris; at the London (Royal Free Hospital) School of Medicine for Women on October 2, at 4 p.m., by Mrs. Bryant, D.Sc.; at the London School of Tropical Medicine on October 10, at 4 p.m., by Dr. Nuttall; at the School of Pharmacy, Pharmaceutical Society, on October 2, at 3 p.m., by Sir Boverton Redwood; and at the Royal Veterinary College on October 2, at 4 p.m., by Mr. W. Hunter. At Guy's, the London, St. Thomas's, and Westminster hospitals there will be no inaugural addresses, but at the first named Prof. Osler, F.R.S., will open the session of the Pupils' Physical Society with an address on "Some Reminiscences of Sir Thomas Browne" on October 12, at 8 p.m.

THE second volume of the report of the Commissioner of Education for the year 1903 has now been received from Washington. The bulky volume of some 1300 pages is largely concerned with statistics, full data being provided concerning every grade of educational institution. Dealing with the income of colleges and universities, the report shows that in the United States the State and municipal aid to higher education during 1903 amounted to 1,591,000*l.*, of which 1,034,000*l.* was granted for current expenses and 557,000*l.* for buildings and other special purposes. The total value of all gifts and bequests reported during the year to the commissioner by universities and colleges amounted to 2,950,000*l.* The three institutions receiving the largest sums for the year under consideration were:—University of Chicago, 487,500*l.*; Harvard University, 351,300*l.*; and Barnard College, 225,600*l.* The universities and colleges in the States of the North Atlantic and North Central divisions continue to receive the greater portion of benefactions, more than 90 per cent. of the total amount being reported by them in 1903. Dr. John Eaton, who was formerly United States Commissioner of Education, contributes biographical sketches of American educational benefactors and of American citizens whose lives were devoted to educational work, and this brightly written section of the volume affords another indication of the way in which the men of wealth in the United States are encouraged by those in authority to interest themselves in educational progress.

THE polytechnics and technical institutes of London will open shortly for the winter session, and the issue of new calendars and syllabuses has begun already. The session of Birkbeck College will commence, we learn from its new year-book, on October 2, when Sir Edward Fry will deliver the inaugural address. Afterwards the class-rooms and laboratories will be opened for inspection, and an exhibition of work will be held in the school of art. The work of Birkbeck College is conducted in close relation with the University of London, courses of study for examinations of the university being provided under recognised teachers of the university. In addition to evening classes in almost every department of learning, there are day courses of work which give instruction in practical and theoretical science, in classics, in modern languages, in commercial subjects, and in English literature. The moderate fees will enable students of limited means to take advantage of the lectures and laboratory work which have been arranged at this central institution. The syllabus of classes at the Sir John Cass Technical Institute has also been received, and supplies gratifying evidence of the excellent provision of scientific and technical instruction which is available in Aldgate. It is satisfactory to find that in addition to systematic courses of lectures, special attention is given to laboratory work with a view to bring home to students the general and fundamental principles of science in association with the work and products with which they are more immediately concerned in their daily life.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, July 20.—"A New Formation of Diamond." By Sir William **Crookes,** F.R.S.

Assuming the following data for carbon—boiling point 3870° ab., melting point 4400°, critical temperature 5800°, critical pressure 2320 ats.—the Rankine or Van der Waals formula calculated from the boiling point and critical data gives for a temperature of 4400° ab. a pressure of 16.6 ats. as the melting-point pressure.

Making similar estimates for other temperatures, it appears that above a temperature of 5800° ab. no amount of pressure will cause carbon vapour to assume liquid form, whilst at 4400° ab. a pressure of above 17 atmo-

spheres would suffice to liquefy some of it. Between these extremes the curve of vapour pressure is assumed to be logarithmic.

In their researches on the gases from fired gunpowder and cordite, Sir Frederick Abel and Sir Andrew Noble obtained in closed steel cylinders pressures as great as 95 tons to the square inch, and temperatures as high as 4000° C. According to a paper recently communicated to the Royal Society, Sir Andrew Noble, exploding cordite in closed vessels, has obtained a pressure of 8000 atmospheres, or 50 tons per square inch, with a temperature reaching in all probability 5400° ab.

By the kindness of Sir Andrew Noble, the author has been enabled to work upon some of the residues obtained in closed vessels after explosions, and he has submitted them to the same treatment that Moissan's granulated iron had gone through. After several weeks he removed the amorphous carbon, the graphite, the silica, and other constituents of the ash of cordite, and obtained a residue among which, under the microscope, crystalline particles could be distinguished. Some of these particles, from their crystalline appearance and double refraction, were silicon carbide; others were probably diamonds. The whole residue was dried and fused at a good red heat in an excess of potassium bifluoride, to which was added during fusion 5 per cent. of nitre. The residue, after thorough washing and then heating in fuming sulphuric acid, was washed, dried, and the largest crystalline particles picked out and mounted.

From the treatment these crystals have undergone, chemists will agree that diamonds only could stand such an ordeal; on submitting them to skilled crystallographic authorities the author's opinion is confirmed.

PARIS.

Aacdemy of Sciences, September 11.—M. Troost in the chair.—Remarks on the present condition of solar researches and on the means of improving them: H. **Deslandres.** The author proposed in 1893 that automatic apparatus should be established at suitable spots capable of registering the surface of the sun and the successive layers of its atmosphere. As this has so far not been realisable, on account of the expense, suggestions are now put forward for the correlation of the work of the observers actually engaged in solar research, and these suggestions will be submitted to the International Union at the meeting to be held at Oxford.—On a differential equation of the fourth order: Gaston **Darboux.**—On some properties of the α rays of radium: Henri **Becquerel.** The author showed, two years ago, that the bundle of α rays behaves as homogeneous in the magnetic field, and also that the trajectory of the particles in a plane normal to the field, instead of being a circle, is a curve the radius of curvature of which goes on increasing with the length of the trajectory. The recent work of Bragg and Kleeman and of Rutherford is discussed, especially the hypothesis of the slowing down of the particles used by the latter to explain the experimental results obtained when a series of aluminium screens is interposed in the path of the rays. The author has repeated his original experiments with the addition of aluminium screens, and the results confirm his views. On this account M. Becquerel thinks that the hypothesis of Rutherford regarding the loss of velocity of the particles must be rejected.—On the total eclipse of the sun of August 30: G. **Rayet.** An account of the results obtained by the expedition from the Observatory of Bordeaux at Burgos, Spain. The weather was bad, and interfered with the work of several of the observers. In spite of this, however, two good images of the corona were obtained by M. Courty with the photographic equatorial. M. Esclangon was able to follow the variations in the polarisation during the eclipse.—On the method of using captive and pilot balloons at sea: **Prince of Monaco.** Details are given of the mode of launching the balloons and of maintaining them at heights fixed on beforehand. The observations were carried out in the Mediterranean and in the trade winds region of the Atlantic, the maximum height attained being 14,000 metres.—On the eclipse of August 30, and on the polarisation of the solar corona: Georges **Meslin.** The proportion of polarised light is sensibly the same in the polar and equatorial regions—it is about 50 per cent. Elliptical polarisation could not be detected.—On two particular cyclic systems: A. **Demoulin.**—On the generalisation of algebraical continued fractions: M. **Auric.**—On Monge's problem: M. **Zervos.**—On the physical units of albuminoid material and on the part played by lime in its coagulation: G. **Malfitano.** By repeated coagulation it was found to be impossible to free the albumin entirely from inorganic substances, and the author regards the precipitate as aggregates of molecules, associated with electrolytes. It is probable that the mechanism of peptonisation consists essentially in a change in the nature of the salts which are associated with these aggregates.—The influence of the eclipse of August 30 on some plants: Ed. **Bureau.** *Acacia dealbata* proved to be the most sensitive to light, and during the eclipse executed the nocturnal movements, whilst other species of "sleeping" plants were unaffected.—On the evolution of the liver: Camille **Spiess.**—The vibration of the eyelids in renal affections: G. **Ullmann.** This has proved a valuable sign in affections of the kidney, and is present at the earliest stages.—The direct solution of the silicates from arable earth and the experiments of Daubrée: L. **Cayeux.** The author controverts the views of Delage and Lagatu on this subject, and holds that the experiments of Daubrée have been wrongly interpreted by these authors.—The waterspout of August 28 at Saint-Maur and at Champigny (Seine): Th. **Moureaux.**—On the meteorological observations made at Constantine during the eclipse of August 30: Henry **de la Vaulx** and Joseph **Jaubert.**—On the phenomenon of moving shadows: Lucien **Libert.**—An earthquake shock registered at Grenoble, September 8: MM. **Kilian** and **Paulin.**

NEW SOUTH WALES.

Linnean Society, June 28.—Mr. T. Steel, president, in the chair.—Description of a new species of Actinotus from eastern Australia: R. T. **Baker.**—Revision of the Australian Curculionidæ belonging to the subfamily Cryptorhynchides, part vii.: A. M. **Lea.**—Descriptions of five new species of Cicindela from tropical Australia: T. G. **Sloane.**

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THURSDAY, SEPTEMBER 28, 1905.

A TREATISE ON PLAGUE.

A Treatise on Plague. By Dr. W. J. Simpson. Pp. xxiv+466. (Cambridge: University Press, 1905.) Price 16*s.* net.

THIS volume deals with the historical, epidemiological, clinical, therapeutic, and preventive aspects of plague, and it marks a distinct and important addition to what has hitherto been written about the subject. It gives a careful and well arranged summary of many writings, ancient and modern, which deal with oriental plague. Many of the ancient writers, some interesting and basing their statements on carefully observed facts, others less interesting and largely fanciful, are here succinctly placed side by side, and the advances or the reverse evolved out of them for subsequent generations are described in chronological order. What the reader of this volume will at once perceive as a marked difference from other works on plague is the recognition of the important bearing of the discovery of the *Bacillus pestis* as the real cause of the disease, and its influence on our knowledge of the manner of spread of the disease and its prevention. In these respects Dr. Simpson, as an epidemiologist of recognised standing, and by his practical knowledge of the bacteriological aspect, is in a distinctly more favourable position than previous writers on plague.

The subject-matter is dealt with in four parts in twenty-one chapters. Part i. gives an account of the history and distribution of plague from the earliest recorded times down to the end of the nineteenth century—chapter i.—and comprises accounts of plague in Syria, Arabia, Mesopotamia and Persia, Egypt, Lybia, Constantinople, and the west of Europe, including Germany, Italy, and England during the sixteenth and seventeenth centuries. The references to the various writers are everywhere carefully given, and include writers like Procopias of Cesarea, Evagrius of Antioch, Gregory Bishop of Tours, Paulus Diaconus, A. v. Kremer, Nicophorus Gregoras, Guy de Chauliac, Ed. Maunde Thompson, Patrick Russell, and Dr. C. Creighton's "History of Epidemics in Britain." This chapter i. contains in thirty-nine pages a review of a vast amount of interesting literature not readily accessible to the ordinary student.

Chapter ii. deals separately with plague in India, which at the present time is of special interest to English readers. Before the seventeenth century, since when more or less accurate records are available, "the history of plague in India is veiled in obscurity. That plague did prevail in India in or before the eleventh or twelfth century is certain, for in some of the Puranas which are at least 800 years old there are references to the disease and instructions to the Hindus as to the precautions to be taken in the event of its appearance. One of these is that whenever a mortality among the rats of a house is observed the inhabitants are to leave" (p. 40). There is evidence of extensive pestilences in India in the fourteenth, fifteenth, and sixteenth centuries. At the beginning of the seventeenth century plague broke out in the Punjab and spread over different parts of India, the outbreaks in Surat, Bombay, and Bijapur towards the last part of the seventeenth century having been of a particularly virulent character.

"Nothing more is heard of the disease (p. 46) on the western side of India until 1836, when the Pali plague broke out in Marwar in Rajputana and lasted until 1838 (Dr. Forbes)," and according to the same authority this epidemic was brought from Asia Minor and Mesopotamia. Next comes the consideration of Garwhal and Kumaon (both at the southern slopes of the Himalayas), which are held by all authorities to be an endemic centre; "fortunately this centre is comparatively an inactive one as regards its powers of diffusion." Simpson, therefore, does not countenance (see also later) the somewhat sensational suggestion by Hankin that the epidemic in Bombay in 1896 and since was due to importation by fakeers from Garwhal. Chapter iii. deals in an exhaustive manner with the present pandemic, which is traced from Yunnan by the trade routes into different parts of China, and finally, in 1894, into Canton and Hong Kong. The outbreak and course of the epidemic into these two places are described from personal inquiries, as also the manner and extent to which these localities became centres of distribution of the plague to Bombay in 1896. The course and nature of the epidemic in Bombay Presidency, its extension into other presidencies and other countries, are illustrated by carefully executed maps.

Part ii. deals with the epidemiology of plague. Having briefly discussed the discovery of the *Bacillus pestis* by Yersin and Kitasato as the real cause of the disease, the author gives an account of the morphological and cultural characters of the microbe, of its vitality under various adverse conditions (heat, cold, drying on various substances) as asserted by various observers, and finally of its general effect and its pathogenicity after inoculation into rodents (chapter iv.).

In chapter v. the relationship of epizootics to plague is fully described. That rats and mice are susceptible to natural infection has been observed and mentioned by many writers, ancient and modern (Book of Samuel, vi., Bhajawata Purana, Nicophorus Gregoras, Lodge, Forbes, and many others). Dr. Hunter, of Hong Kong, and the author himself have published charts (reproduced) which give a comprehensive account of the parallelism of the human plague and rat mortality. While it is universally admitted as proved that in some epidemics the mortality of rats from plague coincides with the appearance of plague in the human being—either preceding it, synchronous with it, or following it—there is, on the other hand, good evidence (collected by the Indian Plague Commission, and discussed by Dr. Bruce Low in his Reports and Papers on bubonic plague, 1902) to show that epidemic outbreaks of plague in the human subject are not necessarily connected with plague in the rat. This is a point which ought not to be lightly passed over; it is unfortunate

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that in recent years it has been assumed by some epidemiologists that the essential factor in the appearance and spread of plague is the rat, whereas there exists good evidence that plague was introduced into, and broke out in, a locality in which neither antecedently nor concurrently any such epizootic was noticed—to mention, amongst others, the outbreak of plague in Oporto, and in Glasgow, 1900. No one questions the fact that plague has occurred on board ships in which plague rats had been found, nor that such rats on landing may carry and spread the disease amongst rats on shore, which themselves become a focus for plague amongst human beings; but it would be a serious omission on the part of sanitary officers were they to assume that this is the only, or even the chief, mode of importing the disease oversea or from one locality to another.

Chapter vi. deals with the different views regarding the etiology of pandemics and epidemics of plague, views which, with few exceptions, fall within periods antecedent to the discovery of the *Bacillus pestis*, and attributed a primary causality to influences which we now know to be accessory, though important, circumstances in the dissemination and spread of the disease, as, for instance, famine, scarcity, insanitary disposal of the dead, and others.

The known variations in diffusive powers of epidemics and the effect of seasonal influences are considered in chapter vii., and are illustrated by charts and diagrams, without, however, bringing us nearer to an explanation of the fact that seasonal influences play an important part, unless we accept as seriously meant the statement by Gottschlich, according to whom the seasonal periodicity of plague in Egypt is to be explained by the seasonal breeding period of the rat (p. 158).

The variation in virulence of plague epidemics is dealt with in chapter viii., and is illustrated by an account of various epidemics which have occurred in Astrakhan and Vetlianka, 1877–8; Avignon, 1348; Kathiawar, 1820; Pali, 1836; Marseilles, 1720; Egypt, 1834, and others. From these the author concludes that not only do epidemics amongst themselves show great variations in virulence, but that an at first mild epidemic is succeeded by one of great virulence in the same or subsequent years, and further that the various types may be running concurrently in the same locality and at the same time, *e.g.* at Kathiawar, Pali, Marseilles, Russia, and other places. The often observed fact that glandular swellings without fever may precede or follow plague prevalence is dwelt upon, without offering for it a satisfactory explanation, beyond the suggestion that variation of virulence may be due to change in virulence of the *Bacillus pestis* with change in the surrounding physical conditions, or to differences in susceptibility of those attacked, such as are brought about by scarcity and famine, poverty, insanitary dwellings, &c.

The conditions which foster endemicity and epidemicity are considered in chapter ix. The influence of the various at present existing endemic centres on dissemination of plague to exotic countries, the different conditions (poverty, misery, deficient food, overcrowding, insanitary dwellings) under which the various peoples have lived and still live, as, for instance, in the Himalayas, in Bombay, Canton, Hong Kong, Cape Town, and others, play an important part in predisposing to plague, "and it is in a population living under these social and local conditions that plague usually commits its greatest ravages" (p. 193).

The modes of dissemination from one locality into another and within an infected locality are described in chapters x. and xi. respectively. As to the first, illustrations are given that plague travels by the most frequented trade routes, that persons sick with or incubating plague carry infection, so also infected clothes and personal effects; that infection conveyed to a new centre (infected cargoes and infected rats) may affect rats before human beings; that owing to panic caused by plague breaking out in a given locality, open and secret flight of inhabitants are instrumental in the dissemination of the disease. In the dissemination of plague within an infected locality, importance is attached in the first place to the high infectivity of the pneumonic form of plague, as contrasted with simple bubonic plague, which is not directly infectious. Next stands the infectivity of the septicæmic form, in which the excretions contain the *Bacillus pestis*, wherefore clothes and rats play an important *rôle*. In the conveyance of plague from the rat to man, the part that insects—fleas, lice, bugs, ants—play is brought into prominence. In support of this theory, no valid experimental evidence is brought forward; what there is mentioned is more of the nature of strong belief. It is to be regretted that such prominence is given to this mode of dissemination, seeing that beyond the theoretical possibility, namely, that a blood-sucking insect of a plague-infected animal the blood of which, presumably, contains the *Bacillus pestis* might be the means of causing by its bite cutaneous inoculation of a new individual, including the human, there is not sufficient evidence that such has actually been observed either naturally or experimentally. All the direct evidence at present available is of a negative character. The numerous modes of conveyance of plague from man to man, from rat to rat, from rat to man and *vice versâ*, which have actually been observed both under natural as also under laboratory conditions (chapter xiii.) are quite sufficient to account for all the facts without ascribing to the flea any other than a very restricted and accidental *rôle*, if any.

Part iii. deals with plague in the individual. The morbid anatomy and pathology, including histology and distribution of the *B. pestis* in the different tissues, are described in chapter xii., as also the details of several autopsies of typical plague cases; whereas chapter xiii. gives an extensive description of the various channels by which an individual may receive the infection—the skin, and hence directly into the lymphatics; the skin, and hence directly into the bloodvessels; the mucous membranes, particularly of the fauces; the respiratory tract. The author accepts the three-fold grouping of plague infection made by the Indian Plague Commission

according to the duration of the incubation period in well ascertained cases.

The clinical symptoms, temperature charts, and some excellent photograms of the various forms of buboes in the living, the clinical history, treatment, and *post mortem* appearances of several specially selected cases are treated in a very readable manner in chapter xiv. While chapter xv. deals with the diagnosis and prognosis both from a clinical and bacteriological point, chapter xvi. is specially devoted to treatment, dealing with the methods used in the past, before the intimate nature of plague had been recognised, and in the present day, when Yersin's serum is extensively employed, giving statistical tables of the results of the use of this serum in Bombay, Karad, Karachi, Oporto, Natal, Hong Kong, and Brisbane, as also of Lustig's serum (p. 325), of that of Bondi and Terni, and of Kitasato.

This chapter concludes with a general account of prophylactic measures to be employed in an infected house, and of the injection of Haffkine's prophylactic into persons who have been exposed or are likely to be exposed to infection. Of the value of this prophylactic Dr. Simpson has no doubt, and recommends its immediate application.

Part iv. deals with measures for prevention and suppression of plague, those that were employed before the discovery of the *Bacillus pestis* (chapter xvii.), as also those at present in use (chapter xviii.). Amongst the former the measures used by the Venetians in 1348—in advance of all other countries and nations—deserve special notice, inasmuch as those measures were the first of a rational and organised nature, and practically are fundamental for all subsequent improvement and enlargements—lazaretto system of isolation, quarantine of men, merchandise, articles, and objects of various kinds. Amongst the existing measures are those agreed upon by the different Governments at the Venice Convention of 1897, and at the Paris Convention of 1903. Amongst the latter the importance of the destruction of rats is receiving a prominent place. While the use of fumigation of ships by means of the Clayton process, described in detail (pp. 359–365), unquestionably deserves the first place, undue prominence is given by the author to the Danysz bacillus (capable of causing acute fatal disease in rodents) as a means of rat destruction in localities other than ships. Owing to this prominence, the use of this microbe seems liable to lead to considerable disappointment; while the results of distributing with the food either cultures of this microbe or animals infected with it in the laboratory has been fairly satisfactory in some localities in destroying rats, in other localities it has been unsatisfactory. In some of the warehouses in the London Docks we distributed several dozens of cultures prepared by, and bought directly of, Dr. Danysz, as also a number of subcultures mixed with various foodstuffs, and a number of rodents (guinea-pigs, mice, and rats) dead after injection with virulent culture of the microbe; but while all these materials had been taken away by the rats of the warehouse, there was not a single dead rat found in consequence, nor was there afterwards any diminution of their number noticeable. Such unsatisfactory results have been observed also in other localities; it appears that the result depends not only on the virulence of the cultures (difficult to control), but also, and in a marked degree, on the species of rat. Moreover, recent observations show that even rats of the same species, but derived from different localities, are not susceptible to the Danysz virus in the same manner and to the same extent. The use, therefore, of the Danysz bacillus in one form or another can at best be considered only as a half-measure. It is precisely against half-measures, so frequently and so readily resorted to by indolent corporations and powers that be, that the author justly raises his voice in no uncertain manner (chapters xviii. and xix.), and we cannot help regretting that such prominence should have been given to a method falling far short of the drastic measures required to ensure the safe destruction of this dangerous vermin.

Chapter xx. is entirely devoted to a description of the nature, use, and results of preventive inoculation with Haffkine's plague prophylactic. The volume finishes with a reprint of the results of the International Sanitary Convention of Paris of 1903 *re* plague and cholera.

From the foregoing summary it will be seen that Dr. Simpson's "Treatise on Plague," dealing as it does with the disease from every aspect, is worthy to take a place in the foremost rank of the literature of the subject, and we have no doubt that it is destined to become an important and valuable aid to the student, the medical officer of health, to the epidemiologist, the sanitarian, and last, but not least, to the administrator.

E. Klein.

ASTRONOMICAL STEREOGRAMS.

Our Stellar Universe. A Road-Book to the Stars. By Thomas Edward Heath. Pp. 75. (London: King, Sell and Olding, Ltd., 1905.) Price 5*s.* net.

Our Stellar Universe. (Six Stereograms of Sun and Stars.) By Thomas E. Heath. (London: King, Sell and Olding, Ltd., n.d.) Price 3*s.* net.

In the first of these two volumes Mr. Heath has collected and amplified several articles which previously appeared in *Knowledge*, and in which he made a satisfactory attempt to bring home to the understanding of "the man in the street" the knowledge so far available as the result of the determinations of stellar parallaxes. It is, truly, as the subtitle indicates, a "road-book" in which the contours, or perhaps one should say the depths, as well as the directions, are plainly shown.

The text is really a simple, detailed description of the eight figures contained in the volume, all of which have been especially prepared by the author himself. Fig. 1 shows the sun and his attendant planets drawn to scale. In Fig. 2 the relative distances of all stars known to be within sixty light-years of our system are shown by placing the objects on a background formed by a map of the home counties, taking Greenwich as the point of departure,

the "sun-powers" of the various stars being represented by a system of symbols. Fig. 3 similarly treats all those stars within 480 light-years, a map of N.W. Europe constituting the background. The scale employed for the stellar distances is an interesting one, which takes as its unit the distance of a star situated at one light-year from the solar system. Mr. Heath fortuitously discovered that by calling this unit one mile the sun's distance is almost exactly represented by one inch.

Figs. 4 and 5, of which detachable duplicates are given in the book, present really beautiful pictures when used with a stereoscope, the star images standing out in numerous planes, some quite near to the eye, others apparently infinitely remote. The conception of the three-dimension character of space is most vividly impressed by these charts, the first of which represents the stars as viewed from a plane situated 500 light-years from the sun by eyes 107 light-years apart, the second a similar view at a distance of 100 light-years as seen by eyes 26 light-years apart.

The sun-powers of various stars are more especially dealt with in Figs. 6 and 7 and the accompanying text, whilst Fig. 8 represents a view of the known universe as it would appear to an external observer looking in the direction of R.A. 6h.

All the data (*e.g.* parallaxes, spectral types, sun-powers) used in constructing the various diagrams and discussed in the text, are given in tables which form an interesting and useful appendix to the volume. Avowedly written in a popular form, the book contains much that will not appeal to the astronomer, *e.g.* the reference to the Dogger Bank incident on p. 17, but should prove of interest and assistance to the amateur tourist in space by visualising the real interpretation of stellar parallaxes.

In the second of these two volumes Mr. Heath gives us a series of six stereoscopic charts of the sun and stars of which the parallax has been determined, similar to those mentioned above. The scale of the charts here given is one-fifth of that he employed for his large stereoscope, and in all of them the spectator's eyes are supposed to be 26 light-years apart, each drawing being made at any angular distance of 90 degrees from the four adjacent to it. Each view is accompanied by a table similar to those mentioned above.

The idea of representing stars in this stereographic manner is very ingenious, and this book, too, will certainly interest many astronomical readers.

PHYSICAL CHANGES IN IRON AND STEEL.

The Crystallisation of Iron and Steel. An Introduction to the Study of Metallography. By Dr. J. W. Mellor. Pp. x+144. (London: Longmans, Green and Co., 1905.) Price 5*s*. net.

THAT the students of the problems of metallography, particularly in the present unsettled state of affairs, should have for guides only those who have done some considerable amount of active work in the science will be readily acknowledged. A certain amount of familiarity with the metals themselves, their history and behaviour, is also necessary before the subject can be made to live. Reading through the present work convinces one that it is written by an onlooker, and the illustrations entirely support this view of the text. The presentation is without bias, and each theory and method is described and examined as clearly and fairly as the author's evident lack of practical acquaintance with the subject as a whole will permit. For anyone wishing to get an idea of what has been done and desiring a general survey of the scope of metallography, its theoretical aspect, and the problems it endeavours to solve, the book will serve fairly well. For the worker actually in the field, striving to progress in the science, to apply it to his own practical work with metals, and perhaps to endeavour by its aid to solve some of the difficulties that are ever confronting the metallurgist, it cannot honestly be recommended, as to such it will give but little light.

A few examples of the kind of thing encountered may be given. On p. 12, the recalescence curve of steel is shown as rising from 680° C. to about 810° C., whereas the real rise is only a few degrees; p. 14, "Ac2 is higher than Ar2"; p. 49, "excess of ferrite renders the steel ductile and tenacious," whereas pure iron has a tenacity of about 20 tons and pure pearlite of over 50 tons per square inch; p. 50, "2 per cent. carbon alloys are called cast iron" is quite wrong, for tons of steel are made with more than 2 per cent. carbon. Malleability is the essential point here. P. 52, discussing the influences which affect the physical properties, the author omits mechanical treatment—hot or cold work. "Heat white cast iron it forms grey cast iron" is quite misleading. P. 74, ii., is erroneous, and p. 76 is not in accord with the facts, as the writer has many times proved even in ordinary works practice, so there is only left the ingenuity of the explanation and the fact that it leads the reader astray. P. 81, "tenacity is lowered by silicon." Are the researches of Hadfield, Arnold, and Baker not sufficient to the contrary? Their results are not disputed. On p. 88, cleavage fragments are laboriously dealt with as crystallites. The reader is told they are perfect replicas of the larger crystal, and calcite is the example chosen! Sorby's samples are said to be 1 square cm. by 2 mm. thick. The originals are in front of the writer, and their surface area is more than 1 square inch. It may be of little importance, but the statement should either be near the truth or be omitted. P. 106, "the *cheapest* microscope, 16*l*. or upwards," and "it is necessary to have a brilliant light arc lamp, &c.," must discourage many isolated students, whereas much excellent work has been done and is being done with a batswing or a similar burner and a Beck's Star set at about 7*l*. P. 107, "microphotography."

A glossary gives the "nomenclature of metallography," and the present reviewer would like to study the faces of his colleagues of the Iron and Steel Institute's Committee on "The Nomenclature of Metallography" when they find that it is not based on the final report, but on the crude original put out expressly for discussion and amendment. The arduous session's work that followed was evidently

in vain so far as the author and his readers are concerned. The illustrations are taken from well-known workers, but at least the approximate magnifications should be given. Other points, owing to their importance, would require to be traversed in detail, but enough has been said to help those interested to judge whether the book would suit their purpose or not.

A. MCWILLIAM.

OUR BOOK SHELF.

Latins et Anglo-Saxons, Races supérieures et Races inférieures. By Prof. N. Colajanni. Translation by Julien Dubois. Pp. xx+432. (Paris: F. Alcan, 1905.) Price 9 francs.

SIGNOR COLAJANNI, a Socialist deputy and professor of statistics, is a convinced opponent of the doctrine of Anglo-Saxon superiority. The questions which he proposes to himself are, in brief:—(*a*) the meaning of the terms race and nation; (*b*) the existence of distinctive racial qualities; (*c*) the transmission of acquired qualities; (*d*) the equivalence of decadence in the nation and senescence in the individual. He concludes (*a*) that we have no data by which to determine the specific racial attributes of Sergi's European types; (*b*) that the terms superior and inferior, save as an expression of their relative positions at a given moment, have no meaning when applied to nations; (*c*) that acquired qualities are transmitted, especially when segregation favours fixation of the type; and (*d*) that decadence is relative, by comparison with the progress of other nations; nations may, phœnix-like, rise from their ashes and attain a second time to greatness.

Although Signor Colajanni's main arguments are derived from the English and Romance-speaking peoples of the present day, he does not hesitate to invoke the facts of ancient history and the non-European races, and his task is, in fact, one which demands the amplest equipment of historical, sociological, and economic knowledge, combined with an impeccable method and an unerring judgment. Let us illustrate his fitness for his task. A large part of the first half of this work is taken up with the proof of the first and second conclusions cited above; but his method consists largely in putting side by side two or more quotations, *primâ facie* contradictory, and drawing from them the conclusion that both or all are erroneous. He overlooks the fact that criteria are apt to differ; one author may assert the superiority of a race, another its inferiority; unless the standard is the same, the views are not even shown to be contradictory. Even were it otherwise, it is evident that of two contradictory assertions *both* are not necessarily wrong.

The statistical methods of the work are not above criticism; on p. 354 we have 110/3=22; on the following page there is a comparison of the material progress of France and England since 1840; for France the savings banks are included; the deposits show an increase of 2200 per cent. Signor Colajanni has no hesitation in taking this as an index number, but he does not add to the English table any corresponding figure for our savings banks; even, therefore, were it legitimate to take the mean of ten index numbers, regardless of their relative importance, as a fair statement of the changes. his method is ludicrously fallacious.

Signor Colajanni's knowledge of England is probably limited; we learn (p. 279) that our distinguishing traits are rudeness, lack of sociability, and pitilessness, and that these are due to fagging at school. Our lack of generosity and sweetness (*douceur*) are due (p. 124) to our games and violent exercise—football, of course, and perhaps lawn tennis, or, at an earlier age, battledore and shuttlecock. Of Signor Colajanni's logic we may judge when we read (p. 174 *et seq.*) of Anglo-Saxon decadence as visible in U.S.A., and later (p. 302) that only one-fourth of its citizens are Anglo-Saxons.

Signor Colajanni's book, though inaccurate, is not without its good points, but it leaves little permanent impression. The translator has little knowledge of English and German to judge by the strange words that often meet the eye.

N. W. T.

Machine Construction and Drawing. By Frank Castle, M.I.M.E. Pp. viii+275. (London: Macmillan and Co., Ltd.) Price 4*s.* 6*d.*

IN the study of machine construction and drawing the assistance to be derived from books can never be more than of secondary importance. The acquirement of a thorough knowledge of the subject depends principally upon the opportunities which a student may have of coming into daily contact in the workshop with varied examples of good engineering practice, and the use which he makes of these opportunities. Assuming that a youth is fortunately circumstanced, he will be busy at suitable moments compiling a book of miscellaneous notes, containing, amongst other things, many fully-dimensioned sketches taken from machine details lying around him. Along with this work, and very appropriately in the drawing class, he will make working drawings to scale of some of the things sketched in his notebook, and additional examples for sketching and drawing will be provided in the class.

The student will also consult text-books for further information, and the book under review will be found very suitable indeed for the purpose. The author first describes the necessary drawing instruments, and explains their use. He then sets out in detail, with proportional dimensions, various forms of common fastenings, such as rivets, bolts, keys, &c. Then come chapters containing examples of mill work, followed by others dealing with steam-engine details. The final chapter gives a short account of the physical properties of materials used in construction. Sets of useful exercises occur at intervals, and a few calculations of strengths are given; but the latter are wisely kept in strict subordination.

The drawings which abound throughout the work represent good practice, are fully dimensioned, very clearly printed, and will be appreciated by teachers and students alike.

While not free from minor defects, the book can be cordially recommended for use in drawing classes, and to young engineers who are seeking after knowledge on which to base subsequent work in machine design.

Graphs for Beginners. By W. Jamieson, A.M.I.E.E. Pp. 64. (London: Blackie and Son, 1905.) Price 1*s.* 6*d.*

IN order to teach and illustrate the subject, the author in this small volume makes use of a number of interesting graphs relating mainly to technical and commercial subjects, many of them discontinuous, algebraical curves being given only a secondary place, though the logarithmic or compound interest law is dealt with. The significance of the slope at any point of a graph is enforced by simple and effective examples. The treatment is suggestive and interesting, and the author is justified in hoping that the book will tend to cultivate the observation and stimulate the reasoning powers of the young readers.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Preservation of Native Plants and Animals.

FROM London papers recently to hand, I see that at the ornithological congress, on the motion of the Hon. W. Rothschild, a resolution was forwarded to the Premier of New Zealand in regard to the importance of taking steps to preserve and protect the birds on the Auckland and Campbell Islands.

It may be of interest to ornithologists in Great Britain to hear that our local scientific societies had already, in May, memorialised the Government to the same effect; indeed, we asked that protection should be afforded, not only to the birds, but also to the flora.

We have likewise forwarded a similar resolution to the State Government of Tasmania in respect of the penguins on the Macquarie Islands.

The resolution, therefore, of the ornithological congress should strengthen the hands of our local institutes, which bodies are keenly alive to the importance of preserving, as far as possible, the fauna and flora of New Zealand.

The Government, too, has hitherto met our requests in a prompt and generous manner. A couple of years ago, for example, the Otago Institute pointed out to the Minister for Lands that sheep were destroying the alpine flora of the Southern Alps, especially in the region around Mount Cook; the Government at once proclaimed the area as a "reserve," and the sheep were banished.

In fact, the Government is remarkably ready to afford any protection that is possible; and the recent proclamation of the whole of the S.W. portion of the South Island—including the Great Lakes, a vast mountainous, forest-clad area, and the famous fjords—as a "national park," and the prohibition of the use of guns and dogs herein, has already had its effect in the increase in number of some of our rare birds.

You will see, therefore, that we out here, equally with naturalists at home, have at heart the interests of our native plants and animals. W. B. BENHAM.

Otago University Museum, Dunedin, N.Z., August 21.

The Omission of Titles of Addresses on Scientific Subjects.

I VENTURE to ask the attention of "whom it may concern" to the practice in vogue in Great Britain of publishing presidential addresses of scientific societies and of sections of the British Association without any mention of the titles of those addresses. Take, for example, a case quite at random, but just at hand. NATURE of August 17, beginning on p. 368, contains the inaugural address of the president of the British Association with the heading "Part I." On p. 372 of the same number is another presidential address without a title. On p. 378 a third address has no general head, but it has the distinct advantage of four subheads that enable the reader to select at a glance what he wants, and to pass over other matters if he so chooses.

Unfortunately these are not exceptional cases. I have in my library scores of these addresses in the form of separates without a word on the title-page to indicate how they are to be classified in a library. The presidential addresses published in the reports of the British Association are conspicuous examples of this kind of publication. I have taken the trouble to look through these reports from the beginning of the association in 1831 down to 1892, and out of all the addresses of the presidents of the association published in these sixty-one years there are only five that have titles or subtitles. These are the addresses given in 1831, 1839, 1854, 1880, and 1885.

It is easy to see how this absence of title came about originally, but, as seen from this respectful distance, the history of it is nothing to the point. What this busy world wants is help to get at what we are interested in with the least possible waste of time.

This hot haste may seem unbecoming to men of science, or perhaps it may appear that we Americans are in too big a hurry—that we are too much impressed with the motto "time is dollars." But we are not spending all our time chasing the dollar; there are many other nimble things that we are trying to keep up with, and one of them is the progress of science in Europe, along the lines in which we are especially interested.

If a member of so young and giddy a nation might venture to make a suggestion to older and wiser people, it would be in favour of requesting or requiring the presidents of the various scientific organisations and sections of the British Association to provide headings for their addresses so that those of us who have not the time to read all these good things may be able at a glance to pick out what we want especially to see. As matters now stand we are compelled, as a rule, to do one of two things—either to let them all go unread—to our great regret and loss—or to wade through pages upon pages of matter which, however valuable it may be, is out of our line and of no especial interest to us. Such titles, headings or subheads as are here suggested would avoid these difficulties. It would not cost much; it would not take much time, and it would save much of ours and some of your own. We appeal to you for sympathy and help.

JOHN C. BRANNER.

Stanford University, California, September 7.

Protective Coloration of the Inside of the Mouth in Nestling Birds.

THE habit shown by many helpless nestlings, of gaping widely when the nest is approached, is usually explained by supposing that the birds are appealing for food. This explanation has always seemed to me inadequate, for nestlings that gape usually have the inside of the mouth brightly coloured, and in some cases marked with conspicuous spots. Moreover, newly hatched nestlings among the Passeres gape if the fingers are snapped just above them, or if the branch bearing the nest is shaken. It seems a fair inference, therefore, that the act of gaping is often, if not usually, an expression of alarm.

In order to test the effect of the widely opened and brightly coloured mouth, I have several times asked young children to touch the edge of the nest or place a finger in the mouth of one of the birds, and from their hesitation or even refusal to obey I am convinced that the conspicuous coloration, by centering attention upon the gaping mouth, tends to protect the nestling from molestation. Mr. W. P. Pycraft thinks that the bright colours and spots are "guide-marks" to facilitate the proper placing of the food in the mouth by the parents. But persons who rear nestlings find no difficulty in feeding them so long as they gape freely, without troubling themselves about placing the food in any particular region of the mouth. W. RUSKIN BUTTERFIELD.

4 Stanhope Place, St. Leonard's-on-Sea.

Helmert's Formula for Gravity.

ON p. 79 of Everett's valuable "Illustrations of the C.G.S. System of Units with Tables of Physical Constants" (London: Macmillan and Co., Ltd., 1902) the following lines occur:—

"In a Report now printing, which will contain a very full list of results, Helmert adopts, as the most accurate general formula for g reduced to sea level,

$$g = 980.617\,(1 - 0.002644 \cos 2\phi + 0.000007 \cos^2 2\phi).$$

. . . . This may be accepted as the best general formula yet put forward."

The formula alluded to was given first by Helmert in his paper "Der normale Theil der Schwerkraft in Meeresniveau" (*Sitzungsberichte der k. Preussischen Akademie der Wissenschaften zu Berlin,* 1901, xiv., pp. 332–336), but with a different coefficient, namely,

$$g = 980.632\,(1 - 0.002644 \cos 2\phi + 0.000007 \cos^2 2\phi),$$

and it is not reproduced in the report mentioned in the above quotation from Everett, but in a subsequent one (*Comptes rendus des Séances de l'Association Géodésique Internationale,* Copenhagen, 1903, ii., p. 42, Berlin, 1905).

OTTAVIO ZANOTTI BIANCO.

Turin, Via della Rocca 28, September 8.

THE FAYUM.[1]

THE palæontological treasures yielded by the Fayum have made that Egyptian province no less famous among geologists and zoologists than are the "bad lands" of the United States territories, the Sevalik Hills, or Pikermi. The discoveries by Messrs. Beadnell and Andrews of extinct mammals, the study of which serves to clear up the whole question of the ancestry of that strangely specialised group the Proboscidea, are not of less significance than those which enabled Marsh and Huxley to demonstrate how the equally aberrant type of Equidæ originated.

We are glad to learn from the introduction to the present volume that the whole mass of palæontological material which has been obtained by the Egyptian Government has now been handed over to the authorities of the British Museum for the purposes of study and description. While the type-specimens will, we understand, be eventually deposited in the museum at Cairo, a good representative series of duplicates will be retained in this country.

Preliminary notices by Dr. Andrews and Mr. Beadnell himself concerning the osteology of some of these curious extinct forms of mammalian life have already appeared, but for the full details we must await the promised publications to be issued by the trustees of the British Museum. In the meanwhile, we welcome the volume before us, which gives a very clear and suggestive account of the general features of the district in which these splendid discoveries have been made.

The Fayum is a circular depression in the Libyan Desert, having an area of more than 3000 square miles, and is situated to the west of the Nile, some distance south of the latitude of Cairo. The lowest part of the district is occupied by the lake known as the Birket el Qurun, which has an area of between 80 and 90 square miles; but this area appears to be continually diminishing owing to evaporation. On the south-east side of the lake lies a tract of cultivated land, covered with alluvium similar to that of the Nile Valley, and having an area of about 700 square miles. The cultivated area is directly connected with the Nile Valley by a depression through which runs a natural canal—the Bahr Yusef—which conveys water to the Fayum and irrigates the whole of the district.

The remaining area of the Fayum is practically desert, the most interesting part of this desert area being two deep dry depressions in the south-west known as the Wadi Rayan and the Wadi Muêla. These depressions have attracted a considerable amount of attention from engineers in recent years, as being possibly capable of conversion into reservoirs for the purposes of irrigation.

Until the year 1898, when the examination was commenced by the Geological Survey of Egypt, little was known concerning the geology of this district. It was crossed in 1879 by Dr. Schweinfurth, who discovered bones of the extinct cetacean Zeuglodon, and this seems to have been the first indication of the existence of vertebrate fossils in the district. Soon after the commencement of the survey by Mr. Beadnell, under the direction of Captain Lyons, the remains of fish and crocodiles were found to occur in the beds of the Middle Eocene, which had yielded the fossils found by Schweinfurth. A few fragments of bone were also found in the Upper Eocene strata, but it was not until 1901, when Dr. Andrews, of the British Museum, had joined Mr. Beadnell for the purpose of collecting recent North African mammals, that the outcrop of strata was crossed upon which a considerable number of mammalian and reptilian remains lay exposed, many in an excellent state of preservation. Energetic efforts on the part of the authorities of the British Museum and the Egyptian Government have resulted in the rich harvest of palæontological treasures now awaiting description, some of which are familiar to all visitors of the Natural History Museum at South Kensington. The study of these extinct types of mammals and reptiles, in addition to affording much new light on the evolution of living forms, cannot fail to increase greatly our knowledge of the successive stages by which the present distribution of these forms of life has been reached.

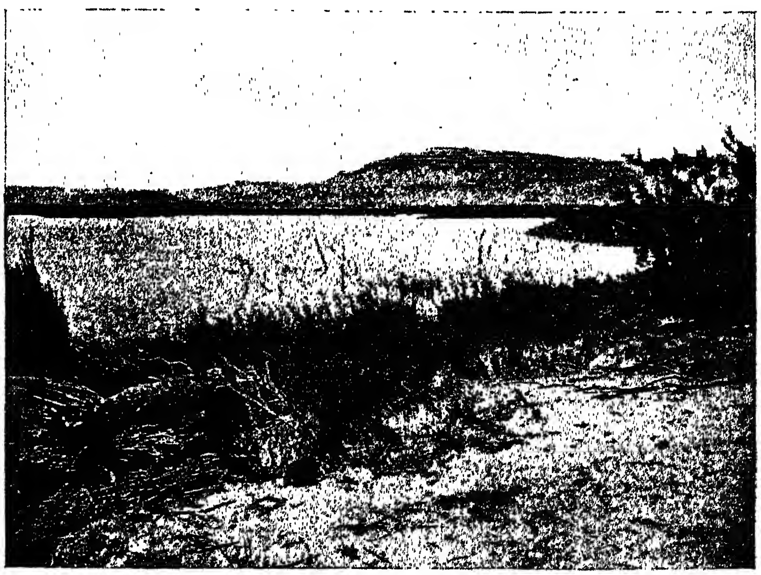


FIG. 1.—North side of the Birket el Qurun, looking West. From "The Topography and Geology of the Fayum Province of Egypt," by H. J. L. Beadnell.

The series of strata which have yielded the interesting vertebrate faunas is clearly described by Mr. Beadnell in the work before us. The beds are admirably exhibited in a number of fine escarpments. At the base are found Middle Eocene (Parisian) strata with an aggregate thickness of about 1300 feet. Nummulites and mollusca abound in these beds, which in their lower part contain Zeuglodon and fish remains, and in their higher portion the older of the two vertebrate faunas. The Upper Eocene (Bartonian) which overlie these have a thickness of 830 feet, and, with some remains of mollusca, yield the abundant remains of the second vertebrate fauna. No Miocene strata have been found in the Fayum, but about 100 feet of fluvio-marine beds, intercalated with contemporaneous (interbedded) sheets of basalt, and containing silicified trees, are referred to the

[1] "The Topography and Geology of the Fayum Province of Egypt." By H. J. L. Beadnell, F.G.S., F.R.G.S. Quarto. Pp. 101. Plates 24. (Cairo: National Printing Department, 1905.)

Oligocene (Tongrian). The youngest beds in the area are gravel terraces, lacustrine clays, deposited on the bed of the ever-diminishing lake, sands blown from the desert, and alluvial deposits.

Mr. Beadnell adduces evidence in favour of the view that the bodies of the animals the skeletons of which are found entombed in the strata of the Fayum were brought down from the African interior by a great stream which flowed in a north-westerly direction, passing through the ancient lake occupying the site of the Baharia Oasis. At that period the shore-line would be near the Fayum, and the Nile would flow into the sea near the same point.

In historical times, as is well known, a large part of the Fayum was occupied by the ancient Lake Moeris. By successive reclamations of the alluvial lands, this lake has probably been reduced to less than one-eighth of its original area, and now constitutes the comparatively insignificant Birket el Qurun.

The work before us appears in the same excellent form as the other memoirs of the Geological Survey of Egypt, issued under the direction of Captain Lyons. There are sixteen plates reproduced from photographs, which give a good idea of the scenery of this wonderful district. We give reductions of two of the plates. In addition to these, there are two geological maps and six sheets of longitudinal sections. There are also woodcuts in the letterpress. The printing of the text of the work and the execution of the illustrations are highly creditable to the Survey Department at Cairo.

J. W. J.

FIG. 2.—Bahr Yusuf at Lahun before entering the Fayum. From "The Topography and Geology of the Fayum Province of Egypt," by H. J. L. Beadnell.

THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION.

THE fiftieth annual exhibition of the Royal Photographic Society is now open. There is a distinct and regrettable falling off in the number of exhibits in the section devoted to scientific and technical photography, but this is in a measure compensated for by the presence of the loan collection of British photographs of a similar kind that was sent to the St. Louis Exhibition last year, though among the latter there are many examples that have been shown in the society's previous exhibitions.

Of the new work, the natural history section is by far the best represented. Miss Turner's set of photographs of the "great crested grebe," and a series of twenty-two lantern slides of butterflies by Dr. D. H. Hutchinson, have been awarded medals. The lantern slides are by the Sanger-Shepherd three-colour process, and illustrate the usefulness of this method for recording rare varieties. In some of the slides the colours are notably excellent, perhaps as perfect as any mechanical colour process will ever produce. Some of the photographs of "nesting swans" by Mr. Douglas English must have been taken at considerable risk, for in two or three of them the bird is shown flying at the photographer in anger. Another example (No. 237) will be found in the west room among the pictorial photographs, and close by (No. 216) is a very fine photograph of sea-gulls, the foremost of which are in the act of alighting on the water. Of other photographs that record slower movements, the chief are a series of seven by Mr. W. Farren of the "skin moult of the caterpillar of the privet hawk-moth," a series of eight photomicrographs (×30) by Mrs. Kate J. Pigg showing the germination of a grass seed, and two photographs of the same oak, the one taken more than fifty years before the other, by Mr. J. B. Hilditch. The earlier photograph of the oak was exhibited at the first exhibition of the Royal Photographic Society (then the Photographic Society of London), and is at least as good a piece of work as the later, the main difference from a technical point of view being that the exposure necessary for the first was three thousand times as long as that given for the second. There are many other photographs of living things, but the bee photographs of Mr. Oliver G. Pike deserve special notice. The difficulty was to get light enough without causing the bees to stop their work, and Mr. Pike has succeeded.

Of other work in the technical section there are photomicrographs showing the structure of various metals and alloys by Mr. E. F. Law, some interesting wave photographs by Dr. Vaughan Cornish, and a number of radiographs by Dr. Thurstan Holland which well illustrate the possibilities of modern methods. The only "natural colour" photograph that we discovered, other than the transparencies by the Sanger-Shepherd method, is a three-carbon print by Mr. Brewerton. We think he has sent as good examples in previous years, but whether or not, what we want to show the capabilities of three-colour work are the finished print, produced without handwork, by the side of the object or painting that it represents. Some commercial work is excellent, but its measure of perfection is due to retouching.

The loan collection from the St. Louis Exhibition will doubtless prove more interesting to many than the new work, because of its greater variety. Some of these exhibits are of historic interest, such as Sir William Abney's photograph of the spectrum in the infra-red, and General Waterhouse's examples of photomechanical work. There are a very great many

photomicrographs of etched metals and alloys, some astronomical and spectrum photographs, and Mr. Edgar Senior's photomicrographs of sections of photographic films, including those of colour photographs by Lippmann's process which demonstrate that the silver deposit is in layers.

In the trade section there are many interesting exhibits. Doubtless the greatest novelty is the demonstration of the three-colour process called "pinatype," which is claimed to be the amateur's method of colour printing on paper. Three prints in chromated gelatin are made from the ordinary three transparencies, and these are each caused to absorb its proper colour by soaking it in the proper dye solution. The prepared paper that is to bear the print is squeegeed on to each of these coloured "print plates" in turn, and duly absorbs the colour. Thus the three colours are absorbed into a single film. The examples we saw were of various degrees of merit.

PROF. LEO ERRERA.

LEO ERRERA, professor of botany in the University of Brussels and member of the Royal Academy of Belgium, whose death on August 1 has already been announced, was born in 1858. He merited preeminently the title of professor, for not only was he gifted as few men are gifted with the faculty of giving a clear and precise explanation of complicated problems, and of impressing upon the minds of his hearers his conclusions, which were well reasoned and supported by facts and conceptions, but he was also one of those teachers who recognised that it is not possible to improvise a lecture, however simple or commonplace, without bestowing upon it lengthy and conscientious preparation. In addition to the critical judgment which characterised his teaching, he always kept it abreast of scientific knowledge; each year, even in the case of his elementary courses, his lectures were looked through, revised, and brought up to date so as to include the latest results in the subject.

Prof. Errera was one of the first teachers in Belgium who had the courage to declare that practical work should take precedence of theoretical studies, which alone had formed the ordinary courses up to that time. He was convinced that a student should only accept as true what he had verified for himself, and that it is not sufficient to know scientific results without becoming acquainted with the methods employed. With this object he established in 1884, when he was appointed professor in the university, the laboratory for vegetable anatomy and physiology which became later the Botanical Institute.

He was wonderfully assisted by the remarkable facility with which he assimilated all current literature. He read Danish and Swedish without any difficulty, and at the congresses in which he took part, whether English, German or Dutch, he invariably excited admiration by his correct and expressive rendering of foreign languages. It was not surprising that at the International Botanical Congress held at Vienna last June he was nominated president for the next congress, to be held at Brussels in 1910.

The worries of teaching did not cause Errera to forget that it is the duty of every scientific man to contribute to the increase of that knowledge which has been handed down to him. His energy was especially productive along four lines of research.

When Darwin had attracted attention to the importance of cross-fertilisation among plants and to the part played by insects in the transfer of pollen, Errera as early as 1878, recognising the full import of this discovery immediately set to work to study with his keen experimental insight the genera Penstemon and Primula, and *Geranium phaeum*.

Later, while he was working in De Bary's laboratory at Strasbourg, he discovered in certain fungal cells a substance then unknown which gave all the reactions of glycogen. This is a body allied to starch that was conclusively shown by the great Claude Bernard to be of great importance in animal physiology. By degrees Errera recognised glycogen in all the groups of fungi, and was able to assign to it the same function, *i.e.* that of reserve carbohydrate, as it has in animals. His first researches on this subject were published in 1884, and constituted his thesis for admission into the University of Brussels.

Prof. Errera initiated a series of papers on the *rôle* of alkaloids in plants. The origin and *rôle* of these poisons in plant economy formed, and still forms, the subject of discussion. The papers of Errera and his pupils tend to prove that alkaloids are decomposition products of nutrition, but that they may be utilised by plants as a defence against herbivorous animals.

He was one of those who realised the importance which attaches to molecular forces in the structure of living beings and in all the obscure phenomena of nutrition. Basing his investigations primarily on the important works of the physician Joseph Plateau, the illustrious professor of the University of Ghent, Errera showed that cellular membranes behave in the same way as if they obeyed the laws which regulate the reaction of liquid films such as are produced in blowing soap-bubbles. His first communication on this subject dates from 1886.

But not content to lead the way in the domains of science which we have outlined and to direct the work of his students therein, he also pursued many investigations in very diverse subjects. He did much to improve the methods of microscopical technique; he simplified greatly the microchemical examination of certain substances; he published ingenious theories on the mechanism of sleep, and contributed lectures on widely different subjects varying from pedagogy to natural philosophy; and all his publications were marked by a clearness and purity of style that are not surpassed in the writings of any other man of science.

JEAN MASSART.

NOTES.

MR. G. B. BUCKTON, F.R.S., author of several monographs on entomological and other subjects, died on September 26, at eighty-eight years of age.

WE regret to see the report that Sir William Wharton, who was prevented by illness from leaving Cape Town with other members of the British Association last week, is suffering from enteric fever complicated by pneumonia. His condition on Monday showed a slight improvement.

AN earthquake shock was felt in Stirling, Dollar, and Alloa shortly before midnight on Thursday, September 21. The shock travelled in a similar direction to that of July 23, namely, to the south-east, but it was of slightly longer duration and more violent in character. In Stirling pictures and crockery were shaken and articles of furniture moved, and a sound like thunder was heard. At Corton railway signal-cabin all the bells were set ringing. At Bridge of Allan the shock was felt very decidedly. In Bannockburn and in the neighbouring villages the impression was of a serious explosion. Comrie was only slightly affected: a low rumbling sound was heard, but no damage was done.

AN electrical exhibition on a large scale was opened at Olympia, Kensington, on September 25 by the Lord Mayor of London. The exhibition is under the auspices of the National Electrical Manufacturers' Association (Incorporated), and is intended to demonstrate the powers and uses of electricity in domestic, manufacturing, and commercial directions. Among the special exhibitors are the General Post Office and the Marconi Company. The Institution of Electrical Engineers is taking an interest in the exhibition on the educational side; and a series of popular scientific lectures and demonstrations has been arranged upon wireless telegraphy, electric motor developments, domestic lighting, telegraphy, telephones, and other subjects.

IN NATURE of July 13 (p. 244) there appeared a letter by Mr. Rotch, director of the Blue Hill Meteorological Observatory, U.S.A., describing the Franco-American expedition for the exploration of the atmosphere in the tropics which was sailing on M. Teisserenc de Bort's steam yacht *Otaria*. During a two months' cruise, the scientific members of the expedition, Messrs. Maurice, of Trappes Observatory, and Clayton, of Blue Hill, executed thirty-two soundings with balloons and kites, and made observations on two tropical peaks, all between latitudes 9° and 37° N. and longitudes 16° and 31° W. A southerly or south-westerly return trade was found at a height of about two miles in the tropics and an easterly wind in the equatorial regions, confirming the generally accepted theory of atmospheric circulation. While the detailed observations are to be published in a special volume by Messrs. Teisserenc de Bort and Rotch, the general results of the investigation will, it is hoped, be embodied in an article which will appear in the columns of NATURE.

THE first congress of the International Surgical Society was held from September 18–22 at the Palais des Académies in Brussels under the patronage of King Leopold. A correspondent of the *Times* says that more than two hundred delegates attended, representing the following countries:—Great Britain, France, Germany, Austria-Hungary, the United States, Belgium, Holland, Switzerland, Japan, Russia, Spain, Portugal, Sweden, Norway, Italy, Denmark, Greece, Finland, Rumania, Servia, and Egypt. The subjects discussed were of a purely technical order, and papers were read on the latest development of surgical science. An interesting feature of the congress was an exhibition of the latest surgical appliances. The delegates received a cordial welcome from the Government and municipal authorities and from their local colleagues. The last meeting of the congress was held on Saturday, September 23. During the session a congratulatory telegram was sent in the name of the society to Lord Lister on the great progress of surgery directly resulting from his antiseptic discoveries. It was resolved that the second congress should also be held in Brussels in 1908. Prof. V. Czerny, professor of surgery in the University of Heidelberg, was appointed president, and the various national committees were also nominated.

THE *Victorian Naturalist* announces the death of Mr. H. T. Tisdall, formerly president of the Field Naturalists' Club of Victoria, and an active botanical teacher and investigator. In September, 1883, he contributed his first paper to the club, the title being "A Botanical Excursion in North Gippsland." Having to a great extent exhausted the phanerogams of the district, he was induced by Baron von Mueller to turn his attention to the cryptogams, with the result that he became an authority on fungi, and at the meeting of the club in February, 1885, contributed a paper entitled "The Fungi of Mt. Baw Baw," in which he described some twelve species of the genus Agaricus. In November of the same year he contributed a further paper on the fungi of North Gippsland, in which he made some important remarks regarding the fungus then known as *Mylitta australis*, "Native Bread." During the interval of nearly twenty-one years between his first and last papers, he contributed numerous papers to the meetings of the club, all relating more or less to botany, either as bearing on a particular branch or descriptive of trips or excursions in search of specimens. In addition to his knowledge of Victorian phanerogamic and cryptogamic plants, Mr. Tisdall was, at the time of his death, an authority on marine algæ. He contributed an article on the flora of Walhalla to the mining department's report on that goldfield (1902), as also some useful papers to the meetings of the Australasian Association for the Advancement of Science, which included a list of the marine algæ of Victoria.

IN *l'Anthropologie* (xvi., No. 3) M. Boule gives a more detailed account of the machine-made eoliths referred to in his paper in the *Comptes rendus*, translated in NATURE of August 31 (p. 438). From the descriptions and illustrations, it appears that among the specimens collected

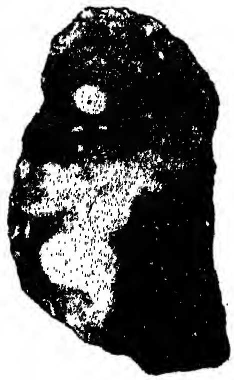


FIG. 1.

FIG. 2.

by M. Boule in a few minutes from the great pile of refuse flints are all the forms regarded as characteristic of eoliths. In particular, we find the bulb of percussion present in more than one example; one of these, shown in Fig. 1, is remarkable for what would, in an artificial

FIG. 3.

flint, be called "beauty of work" on one of the edges (Fig. 2); others, of which Fig. 3 is a good example, show the notch, which, like the bulb of percussion, is commonly regarded as a criterion of human workmanship. From the researches of M. Boule, it seems that the eolith should

no longer be cited in proof of human antiquity greater than can be assumed on other grounds. Eolithic forms may be due to human agency, but independent proof of the contemporary existence of man in the area in question is henceforth indispensable.

THE latest issue (vol. viii., part i.) of the *Transactions of the Norfolk and Norwich Naturalists' Society* contains a number of interesting papers, mostly dealing with the natural history and antiquities of the county. The papers on local biology include one on the water-beetles of the "Broads" by Mr. F. B. Browne, another on the hydrachnids of the same district by Mr. C. D. Soar, notes on the Yarmouth herring-fishery of last year by Mr. T. J. Wigg, lists of Norfolk lichens and liverworts by the Rev. E. N. Bloomfield, and an account of the rotifers of the county by the Rev. R. Freeman.

WE have received from Dr. E. M. Goeldi, director of the museum at Parà, a budget of separate copies of papers by himself, published, with the exception of one, in the *Comptes rendus* of the sixth zoological congress held at Berne last summer. The one exception is from the *Ibis* for April, and deals with the habits of a Brazilian tyrant-bird (*Myiopatis semifusca*); this species, in place of being insectivorous, feeding on the fruits of a parasitic plant and disseminating the seeds, thus causing harm to arboriculture. The other papers relate to rare animals from Amazonia, the yellow-fever mosquito (*Stegomyia fasciata*), and the habits of ants of the genus Atta.

WE have received two new parts of the reports of the scientific results of the voyage of the *Belgica*, 1897–9, issued at Antwerp, in one of which Prof. H. Leboucq discusses the development of the flippers of Antarctic seals from the point of view of the evolution of the pinnipeds in general, while in the second Mesdames Bommer and Rousseau describe the funguses collected during the cruise, all of which, with the exception of a single Antarctic specimen, were obtained from Tierra del Fuego. Judging from the collection, the fungus-fauna of the latter area appears to be a rich one of which but little is at present known. Prof. Leboucq's article is the first of a series on the "organogenie" of the seals. In the case of both memoirs we may direct attention to the difficulty they present to recorders of biological literature, or, for that matter, to anyone who desires to quote from them. They are respectively headed "Zoologie" and "Botanique," but, despite the fact that they are not the first issues of those two series, each is separately paged, and neither bears any volume number. Consequently the whole title has to be quoted for reference purposes.

ACCORDING to the report for the year ending in May last, the Rhodesia Scientific Association, now in the seventh year of its existence, continues to make satisfactory progress, both as regards the length of its roll of members and in the work accomplished. With the report we have received a copy of the fourth volume (1903–4) of the association's Proceedings, which contains a number of papers dealing with the biology and antiquities of the country, together with one on its soils. The latter do not appear to be so promising as might have been hoped, most of them possessing only a moderate degree of fertility, and none exhibiting that redundant growing capacity we are accustomed to associate with virgin lands. Perhaps the most generally interesting paper is one on a new gladiolus which grows in the spray of the Victoria Falls, and has therefore been called the "Maid of the Mist." Four bulbs were sent to England, where by aid of constant syringing they were induced to bloom in a hothouse, when it was found that the petals are so arranged as to form a kind of penthouse for the protection of the central organs from the constant shower-bath existing in the "rain-forest."

AN important issue of the *Palaeontologia Indica* (*Mem. Geol. Survey of India*) is devoted to the description of some recently discovered vegetable and vertebrate remains from the permo-Carboniferous strata of the Vihi Valley, fifteen miles to the south-east of the city of Srinagar, Kashmir. The remains in question were discovered by Noetling in beds apparently underlying the marine Kuling series (Permian) of the Kashmir Valley; and as they include a member of the "glossopteris flora" of the Lower Gondwana system of peninsular India, their discovery serves to confirm the reference of these deposits to the Upper Palæozoic. The plant remains, which are described by Mr. A. C. Seward, include only one generically determinable type, namely, Gangamopteris, from the base of the lower Gondwanas of the peninsula. The vertebrates, for the identification of which Dr. A. S. Woodward is responsible, include a couple of species of the palæoniscid ganoid genus Amblypterus, nearly allied to Lower Permian from Rhenish Prussia, and fragments of a labyrinthodont amphibian apparently referable to Archegosaurus, a genus known elsewhere only from the last mentioned and equivalent formations. No reference is made to the labyrinthodont from the Lower Gondwanas of the peninsula described as Gondwanosaurus, but originally referred to Archegosaurus.

IN the third part of his contribution to the study of the mischievous insects commonly known as leaf-hoppers and their enemies, published at Honolulu as part iii. of the first Bulletin of the Experiment Station of the Hawaiian Sugar-Planters' Association, Mr. R. C. L. Perkins furnishes some very interesting information with regard to the life-history of the parasitic Stylopidæ (Strepsiptera). It appears that although the majority of those degraded beetles infest bees and wasps, a certain number of species are parasitic on leaf-hoppers and other Homoptera, and it is the latter that form the subject of the communication before us. Although death usually follows some time after being "stylopised," many leaf-hoppers are able to procreate their kind after being badly affected by the parasites, especially if by females. The male stylopids, on account of the larger size of the puparia, are, however, much more speedily fatal to the leaf-hoppers, the hole left in the bodies of the latter by the escaping insect being relatively large. Moreover, a fungus immediately makes its appearance, with fatal effect, in the tube; and in artificially infecting leaf-hoppers with stylopids it is considered of the highest importance that the fungus should also be introduced.

THE report on economic zoology contributed by Prof. Theobald, of Wye Agricultural College, to the college journal for the year 1904–5 deals chiefly with the insect pests of field and garden crops, and on this important subject gives a great deal of useful information. During the year Prof. Theobald dealt with about 1200 communications, and his report contains descriptions of the most troublesome pests brought to his notice. Among the pests of fruit trees, the apple aphides *Aphis pomi, A. sorbi,* and *A. fitchii* were much the most destructive. Prof. Theobald points out that these forms have been wrongly described as a single species, *A. mali,* by previous English writers. The aphides do great damage to young shoots, leaves, and blossoms, but it is apparently hopeless to attempt to get rid of them by spraying in the usual

way in spring. The only practical remedy, especially where the first two species are concerned, is to spray in autumn, and a heavy paraffin emulsion is recommended, as injury to the leaves is not a serious matter at this season. The work is troublesome but effectual. In many cases it may be possible to collect and burn affected leaves in autumn, and this is recommended. Prunings should also be burnt before March. In the same report Prof. Theobald mentions a case in which honey-comb was destroyed by the maggots of the window fly (*Rhyphus fenestralis*). The window fly is a very common insect, but has never before been reported as an enemy of the bee, and the case is mentioned as showing how a harmless insect may suddenly change its habits and become a pest.

Two recent botanical parts, Nos. 9 and 11, of vol. xii. of the *Proceedings of the American Academy of Arts and Sciences* deal with systematic work. In the one number Mr. B. L. Robertson collates some American Eupatorieæ, and Mr. J. M. Greenman presents a list of new flowering plants from Mexico and the south-western United States. In addition to the new species, Mr. Greenman proposes two new genera, Lozanella, near to Trema, of the order Ulmaceæ, and Mimophytum, a borraginaceous genus allied to Omphalodes and Cynoglossum. The other part contains the sixth and last of the preliminary diagnoses by Prof. R. Thaxter on new species of Laboulbeniaceæ, a specialised group of minute ascomycetous fungi which live parasitically on insects.

SEVERAL points of interest are noted in a phyto-geographical sketch by Dr. L. Cockayne of the vegetation of the two Open Bay islands, which lie close to the shore of South Westland, a county in the southern island of New Zealand. Characteristic liane formations occur on both islands; on the larger northerly island the dominant liane is a screw-pine, *Freycinetia Banksii*, and in some parts, *Muehlenbeckia adpressa*, of the order Polyonaceæ, is associated with it or takes its place; on the smaller island the Freycinetia is absent, and the Muehlenbeckia forms pure scrub or grows with a large-leaved variety of *Veronica elliptica*. The account appears in the *Transactions of the New Zealand Institute* (vol. xxxvii.), as also a list of newly-recorded habitats for New Zealand plants by the same writer. The identification of a Carex from Chatham Island, as a variety otherwise only recorded from Patagonia, adds another to the list of plants which connects the floras of New Zealand and South America.

AT the age of four score years, Dr. v. Neumayer has the satisfaction of issuing the third edition of his "Anleitung zu wissenschaftlichen Beobachtungen auf Reisen." It is appearing in parts (Jaennecke, Hanover) at a price of 36 marks, and will comprise two volumes, the first dealing with geography and inanimate nature, the second with plants, animals, and man. More than thirty experts are collaborating under Dr. v. Neumayer's editorship, so that each subject will be treated by an expert. The first two parts have already appeared, and contain articles on geographical observations, directions for somatological observations, an anthropological questionnaire, which seems to be identical with that issued by the Berlin Museum for Africa, and, finally, the commencement of an excellent article by Dr. v. Luschan on field work in archæology. No provision seems to be made for an article on a traveller's outfit or general hints; but it would not materially increase the size of the book to do so, and probably its general usefulness would be much increased by the addition. The last edition appeared in 1888, and in many branches of knowledge the advance since that date has been immense. It is therefore a matter for congratulation that Dr. v. Neumayer has been able to supervise the re-issue and gather around him so many able coadjutors.

A COMMISSION has been appointed by the Lieutenant-Governor of the Transvaal to consider the question of the safety of persons travelling in shafts. It will inquire into the structure, material, preservation, and examination of winding ropes and the adaptability of safety catches.

MESSRS. PERCIVAL, MARSHALL AND CO. have published a useful little guide to standard screw threads and twist drills by Mr. George Gentry. Tables are given of the Whitworth standard thread, the British Association standard, bicycle screw threads, the V standard thread, the United States standard thread, the international metric standard thread, watch and clock screws, and twist drills. The guide, which is published at 6*d*. net, is specially designed to meet the needs of the model engineer, and shows in a striking manner the necessity for the general adoption of standard threads as advocated in an article recently published in NATURE (August 31).

THE current issue of the *Bulletin de la Société d'Encouragement* contains an important memoir by a Swedish engineer, Mr. Hjalmar Braune, on the influence of nitrogen on iron and steel. That metalloid exerts an influence more harmful even than that of phosphorus, and appears to be the chief cause of the fragility of mild steel. Its presence in iron is not due to the direct combination of the metal with the nitrogen of the air; the intervention of basic slag is necessary. Metal made by the Thomas and Gilchrist process contains more nitrogen than steel made by the acid process, and this explains the inferiority generally ascribed to the former material.

THE annual report on the mineral resources of the United States for 1903 has been issued under the able editorship of Dr. David T. Day. It forms a bulky volume of 1204 pages, and contains, in addition to statistics of production, a large amount of descriptive and technical matter. In 1903, for the fourth time, the total value of the United States mineral production exceeded 200,000,000*l*., iron and coal being the most important of the mineral products. The United States in 1903 were the greatest producers of iron, coal, copper, lead, petroleum, and salt in the world. Tin, it is interesting to note, has been found in commercial quantities in South Carolina, and the mines were actively worked in 1903. The manufacture of arsenious acid, a new industry in the United States, is carried on at Everett, Washington. The production of gypsum continues to show a remarkable increase, owing, doubtless, to the use of plaster of Paris in large modern buildings. There was, too, a notable increase in the production of the ores of nickel, cobalt, chromium, tungsten, molybdenum, vanadium, titanium, and uranium owing to their use for steel-hardening purposes. A great advance in the lapidary industry is also reported. The fact that larger establishments have been formed, which are able to purchase the rough diamonds in greater quantities, has placed the American diamond-cutters in a position equal to that held by those of Amsterdam, Antwerp, and Paris. The cutting of American gems has also assumed large proportions, notably in the cases of the beryls and amethysts of North Carolina and Connecticut, and of the turquoises, sapphires, tourmalines, chrysoprases, and garnets of other States.

THE Department of Agriculture and Technical Instruction for Ireland is publishing a series of Bulletins upon experimental science, and No. 4 of this series, relating to "Voltaic Electricity," has just been issued. It has been prepared by Mr. James Comerton, and is a useful little pamphlet of thirty pages with numerous illustrations. The author states in the introduction that the experiments described are merely intended to introduce the student to the more systematic study of electrical measurements. When the student has worked through the forty-three experiments described in this pamphlet, it is hoped that he will have a fair general working knowledge of voltaic electricity—its generation, measurements, and the purposes to which it can be applied. Primary cells, resistances, galvanometers, and voltameters are illustrated, and their use is described in these pages. The handbook should prove a useful addition to the literature of elementary electrical measurements.

THE principal centres of the calcium carbide industry in France are in the Alps and Pyrenees. At present, according to a writer in the *Journal of the Society of Arts*, there are eleven manufactories capable of producing 40,000 tons of calcium carbide annually. The total output sold during 1904 may be estimated at 18,000 tons. The average yield of gas per unit of weight of carbide is about 40 gallons per pound. The cost price per ton of calcium carbide in Europe was estimated by Prof. Lefevre, of the École des Sciences, Nantes, in 1897, at from 8*l*. to 10*l*. M. Pictet, however, in the same year, thought that the product might be made at the cost of a little more than 3*l*., by the use of a new furnace. Theoretically, said Prof. Lefevre, one pound of calcium carbide ought to produce, by its action upon water, about seven ounces of acetylene. It has been stated by one of the most important of the French firms, speaking of the production of 1904, that this was disposed of at 8*l*. per ton, the standard accepted and declared being about 40 gallons of gas per pound. The product at the factory realises 8*l*. per ton, and the rate for the retail dealer is 14*l*. These figures demonstrate the advances made in manufacturing since the publication of Prof. Lefevre's treatise in 1897.

PROF. D'ARSONVAL describes in the Bulletin of the French Physical Society a new and simple form of apparatus manufactured by the Société Française de l'Acétylène dissous, which serves for the generation and automatic compression of oxygen. The gas is generated by the combustion within the compression cylinder of a combustible substance mixed with potassium chlorate, the heat produced being sufficient to liberate the whole of the oxygen from the chlorate. The largest form of apparatus, the industrial type, gives a production of about 60 cubic feet of oxygen per hour. A new form of oxyacetylene burner is also described by means of which a very intense light is produced by allowing the jet to impinge upon a suitable mixture of the rare earths; lime and magnesia are useless for the purpose, as they are rapidly fused and channelled by the intense heat of the oxyacetylene flame.

DURING the past few years doubts have been expressed by several investigators, notably by Fitzgerald, Kahlenberg, Quincke, and Traube, of the correctness of Van 't Hoff's hypothesis that the osmotic pressure of solutions is purely a kinetic phenomenon due to the impact of the molecules of the solute against a membrane impermeable to them. This hypothesis has been so fertile of results and is so intimately associated with the progress of modern chemistry that any arguments of a subversive tendency have, generally speaking, received little attention. In a recent number of the *Atti dei Lincei* (vol. xiv., ii., p. 5) Prof. A. Battelli and A. Stefanini have brought forward, however, a number of facts which, if subsequently verified, are likely to prove insuperable objections to its validity. A necessary consequence of Van 't Hoff's hypothesis is that isosmotic solutions should, under similar conditions, be equimolecular; but it is stated that several cases have been observed in which solutions possessing very different molecular concentrations are in osmotic equilibrium. The characteristic of these solutions is that they have equal surface tensions, and it is contended that osmotic pressure is essentially a capillary phenomenon. Osmosis would then be a tendency to equalise the surface tensions of the liquids on the two sides of the membrane. The further developments of the authors' experiments will be watched with interest.

AN interesting lecture device for illustrating the superposition of simple harmonic motions of different periods has been submitted to us by Mr. W. C. Baker, of the School of Mining, Queen's University, Kingston, Ontario. A horizontal bar (about 4 cm. deep and 15 cm. long) carries a pointer about 50 cm. long rigidly attached to it. This system, which must be as light as possible, is suspended by two hinges which permit it to oscillate freely about a horizontal axis. To the underside of the bar are attached two pendulums (100 cm. and 75 cm. long) the bobs of which are of equal mass, say 250 grams each. If the pendulums be displaced together through an arc of, say, 15° and then released, the pointer will be set vibrating through an arc which will vary from a maximum when the pendulums are in phase with one another to very approximately zero when they are in opposition, thus illustrating the formation of beats. There is, of course, no obvious relation between the amplitude of the motion of the pointer and that of the pendulums; the oscillations of the latter give rise to periodic forces upon the horizontal bar, and the pointer indicates the resulting motion. We may point out that a somewhat analogous device was shown by Lord Rayleigh during a recent course of lectures at the Royal Institution.

Le Radium for August contains various articles and reviews on all the branches of radio-activity, together with a summary of current researches in this subject.

THE *Revue Scientifique* (September 9) contains an interesting summary on trypanosomes and trypanosomiasis by Dr. Brumpt. In addition to the ordinary pathogenic forms, the trypanosomes of birds, reptiles, and fishes receive notice.

ACCORDING to *La Nature* (September 16), the ravages of the phylloxera in northern Spain are very serious, many of the older vineyards being almost destroyed; and it is becoming a question whether it will not be necessary to substitute cereals and fruit for the vine in the affected districts.

THE *Bulletin of the Johns Hopkins Hospital* for September (xvi., No. 174) contains an interesting historical article on Cotton Mather's rules of health by Prof. William Thayer, together with papers of medical interest. Cotton Mather was a divine who was born in Boston in 1663, a learned man with a remarkable literary style, and his rules are often very quaint.

IN the August number of the *Journal of the Royal Microscopical Society*, Mr. Conrady writes on the application of the undulatory theory to optical problems, and

notes are contributed by Mr. Nelson on the presence of a flagellum at each end of the tubercle bacillus, by Lord Rayleigh on an optical paradox, and by Dr. Lazarus Barlow on a new form of hot stage. The usual summary of current researches concludes this excellent quarterly.

MESSRS. CHARLES GRIFFIN AND CO., LTD., have published a sixth edition of Mr. Andrew Jamieson's "Elementary Manual of Magnetism and Electricity." Several additions have been made in this new edition.

A KEY to the exercises in the second part of Mr. Pendlebury's "New School Arithmetic" has been prepared by the author and published by Messrs. George Bell and Sons. The price of the "Key" is 8*s.* 6*d.* net.

MESSRS. SMITH, ELDER AND CO. have published a sixth edition of Marshall and Hurst's "Junior Course of Practical Zoology." The new edition has been revised throughout by Dr. F. W. Gamble, who has also added short accounts of Monocystis, Coccidium, and Obelia.

THE following popular science lectures will be given at the Royal Victoria Hall, Waterloo Bridge Road, S.E., during next month:—October 3, "A Journey of Surprises: through Yunnan to Tonquin," Mrs. Archibald Little; October 10, "Smokeless Explosives," Mr. J. S. S. Brame; October 17, "The Plants of Other Days: what their Fruits and Seeds were Like," Mr. H. E. H. Smedley; October 24, "My Cruise Around Spain and Portugal," Mr. F. W. Gill.

MESSRS. PHILIP HARRIS AND CO., LTD., Birmingham, have just issued the third edition of their valuable catalogue of scientific instruments required in all departments of instruction or research in physics. The volume contains five hundred pages and is lavishly illustrated, a large number of the pictures representing new instruments or new methods of illustrating the principles of physical science. Many manuals and text-books of physics used in schools have been consulted, and novel forms of apparatus described in them are now made by Messrs. Harris, and appear in the present catalogue. The volume is well bound, and should be very useful for reference by teachers of physics in schools and colleges. No doubt it will find a permanent place on the bookshelves of many laboratories and lecture-rooms.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER:—

Oct. 1. 8h. 52m. Minimum of Algol (β Persei).
„ 4. 5h. 41m. „ „ „
„ 8. 9h. Mars in conjunction with Uranus (Mars 1° 48′ S.).
„ 11. Saturn. Major axis of ring = 42″·28, Minor axis = 8″·46.
„ 14. 15h. Mars in conjunction with λ Sagittarii (mag. 2·9), Mars 0° 7′ N.
„ 15. Venus. Illuminated portion of disc = 0·868, of Mars = 0·861.
„ 19–22. Epoch of October meteoric shower (Radiant 92° + 15°).
„ 20. 6h. 51m. to 8h. 12m. Transit of Jupiter's Sat. III. (Ganymede).
„ 21. 10h. 35m. Minimum of Algol (β Persei).
„ 23. 18h. 24m. to 19h. 30m. Moon occults ρ Leonis (mag. 3·8).
„ 24. 7h. 23m. Minimum of Algol (β Persei).
„ 27. 10h. 15m. to 11h. 35m. Transit of Jupiter's Sat. III. (Ganymede).
„ 31. Uranus in conjunction with ι Sagittarii (mag. 5·3).

NOVA AQUILÆ.—Further news concerning Nova Aquilæ No. 2 is published in No. 4047 of the *Astronomische Nachrichten*. It appears that Mrs. Fleming discovered the existence of the Nova whilst examining the Draper memorial photographs on August 31. A photograph of the spectrum, taken on August 18, shows the hydrogen lines Hδ, Hγ, and Hβ bright and broad, also faint traces of the bright bands at λ 4472 and λ 4646. On that date the magnitude of the Nova was about 6·5, on August 21 it was 7·5, whilst on August 26 it had fallen to 10·0. No trace of the Nova is visible on a plate taken on August 10, although stars of magnitude 9·5 are shown thereon. A plate taken with the Bruce telescope at Arequipa on August 15, with an exposure of four hours, contains images of sixteenth-magnitude stars, but not of any object which can be recognised as the Nova.

A chart of the region, published by Prof. Wolf, shows the position of the Nova in regard to the star B.D. −4°.4663, and further shows that the Nova occupies a position between two spaces which are void of stars down to the fifteenth magnitude.

EPHEMERIS OF THE VARIABLE ASTEROID (167) URDA.—In No. 4047 of the *Astronomische Nachrichten* Herr A. Berberich publishes an ephemeris for the asteroid Urda, which Dr. Palisa recently showed to be variable.

The following is an extract from this ephemeris, which was calculated from the elements published in the "Jahrbuch" and for 12h. M.T. Berlin:—

1905	α (h. m. s.)	δ (° ′)	log r	log Δ
Sept. 28	22 13 18	−10 48·5		
Oct. 2	22 11 46	−11 0·3	0·4463	0·2875
„ 6	22 10 36	−11 9·9		
„ 10	22 9 49	−11 17·2	0·4467	0·3044

Observations made on August 31 and September 5 gave corrections to the above of +4s. and +0′·8.

The following figures indicate the changes of magnitude which were observed during the period July 30–September 5:—

Date	July 30	Aug. 31	Sept. 5
Magnitude	13·0	11·0	12·0

THE ULTRA-VIOLET CHROMOSPHERIC SPECTRUM.—At the total eclipse of 1900 M. H. Deslandres devoted his attention to two special researches, of which the first was to obtain the ultra-violet spectrum of the "reversing layer," and the second to obtain a great number of plates showing the bright lines, in order to detect the changes which might take place in the chromosphere in the interval between the second and third contacts.

In the first research he was successful, and obtained a duplicate series of plates showing the bright spectrum between λ 3000 and λ 5000. The first series was obtained with a prismatic camera of 1 metre focal length, the second with a camera of half this focal length. The prisms employed were of 60° angle, and were made of Iceland spar, whilst the objectives were made up of an achromatic combination of quartz and fluorspar.

The general results obtained from the reduction of one of the larger negatives, which was exposed for two seconds at second contact, are given in No. 9 (August 28) of the *Comptes rendus*, and deal only with the 157 lines photographed between λ 3400 and λ 3066. The chief characteristic of the spectrum in this region, as in the less refrangible region already known, is the predominance of "enhanced" titanium lines. In fact, M. Deslandres states that, considered as a whole, the spectrum is that of the titanium spark. Vanadium and chromium are represented by lines of less intensity, whilst the iron lines are extremely weak, the enhanced lines being considered in each case.

The coronal radiations are represented on two other negatives by well defined lines at $\lambda\lambda$ 3329.6, 3388.0, and 3447.7, the last having the greatest intensity. The same negatives, which were exposed for fifteen and thirty seconds respectively, show several prominences, and here, again, the spectrum of titanium predominates.

The "chronophotographe," an instrument for photographing from six to ten spectra per second at the two contacts, was less successful, the vibration produced by its manipulation spoiling the definition. M. Deslandres gives the details of the instrument, and points out its probable efficiency if suitably mounted.

THE FORMATION OF ICE AND THE GRAINED STRUCTURE OF GLACIERS.[1]

IN the following pages I have the honour to lay before the Royal Society the results of a lengthy research on the formation of ice and the grained structure of glaciers, which may serve as a complement to the previous investigations on the same subject published in the *Philosophical Transactions* and *Proceedings of the Royal Society* by Forbes, Tyndall and Huxley, Tyndall, Faraday, T. Graham, J. F. Main, J. C. McConnel, and D. A. Kidd, and elsewhere by Guyot, Agassiz, James Thomson, and Sir William Thomson (now Lord Kelvin), Hermann and Adolf Schlagintweit, Person, Leydolt, Rüdorff, Bertin, Grad, and A. Dupré, Moseley, A. Heim, J. T. Bottomley, K. R. Koch and Klocke, Forel, Ed. Hagenbach-Bischoff, E. von Drygalski, Mügge, H. Hess, and others.

(1) It will be convenient at the outset to define the precise meaning with which it is proposed to employ certain words, some of which are in vague popular use, while others are less familiar, or new.

By an *oily* liquid will be meant one which has surface tension in the common surface with other liquids with which it may be in contact. According to this definition a solution of any salt will, in comparison with pure water or a weaker salt solution, be called, in certain circumstances, an oily liquid.

An *emulsion* is a watery liquid containing suspended drops of oily liquid, or drops of any sort enclosed in an oily skin. These drops can coalesce into larger drops, or the oily skins can join on to one another, and form a continuous mass of bubbles, or foam. Thus *foam* consists of portions of watery liquid enclosed in, and separated from one another by adjacent partitions of oily liquid. Each space thus enclosed will be called a *foam-cell*, and the enclosing partition the foam-wall. If the foam-cells are very small, and the fluid foam-walls very thin (or invisible), the whole is then a *liquid jelly*. The jelly is stiff, the foam stiff or solid, when the walls or the contents of the foam-cells, or both, have become solid.

"*Nearly pure*" applied to water or ice will be used in the special sense of "containing only very small amounts of any salt." *Salt* itself is used throughout in the general chemical sense, that is, not restricted to sodium chloride.

(2) I have allowed pure water, and water containing dissolved salt, to freeze in the dark at various rates, and to melt away slowly in the dark, in open air, and in sunlight. The ice prisms employed were from 1 mm. to 1000 mm. thick, and as the thawing proceeded their various layers were systematically examined—sometimes for days together—with the naked eye, with the microscope, and with polarised light. The same appearances presented themselves in the same order as those which for thirty-seven years past I have investigated and described in solutions of silicic acid, glue, or other colloids, when these are evaporated to form gelatinous masses or thin films, and develop fissures. I have shown that thin viscous oily films of more concentrated solution exist in a less concentrated solution of the same substance, and form folds, straight and twisted tubes, cylinders or cones, spheres and bubbles, open and closed foam-cells with visible and invisible foam-walls. Thin solid films behave like films of very viscous liquid. Whether the oily films form tubes or bubbles and foam-cells joining on to one another depends on the viscosity of the oily liquid. The mutual inclination of the foam-walls, and their surface tensions, continually change as the concentration of the oily liquid changes, and in the case of invisible foam-walls may depend also on the thickness of the oily film. When the oily film is very thin, its surface tension diminishes with diminishing thickness of the film. Oily foam-walls that are formed against solid surfaces are normal to these surfaces. If three oily foam-walls meet in a common edge at equal angles of 120°, they have equal surface tensions.

The foam-cells of a liquid jelly immersed in water can increase or diminish in volume by the diffusion of water through the foam-wall inwards or outwards, *i.e.* the liquid jelly can *swell* or *shrink*. Two clots of liquid jelly can coalesce into one, which does not occur with clots of solid jelly, nor can these latter swell or shrink.

A liquid jelly becomes for the time being positively or negatively doubly refracting when the viscous walls, or the viscous contents of the foam-cells, are expanded or compressed. A jelly remains permanently doubly refracting when the walls or the contents of the foam-chambers solidify while in an expanded condition.

(3) Now, ice is a liquid jelly, with foam-walls of concentrated "oily" salt solution, which enclose foam-cells containing viscous, doubly refracting, pure or nearly pure water.

(4) The further the temperature falls below 0°, the greater is the viscosity of both liquids—in the walls and in the interior of the foam-cells—and the less the plasticity of the ice.

(5) At very low temperatures, the ice breaks with conchoidal fracture at the surface of the invisible spherical foam-walls, which as the whole cools have contracted differently from their contents.

(6) The "glacier grains" are foam-cells filled with pure or nearly pure ice, and separated from one another by visible or invisible walls of oily salt solution.

(7) The union of two pieces of ice under water ("regelation"), and the increase in size of the glacier grains as they approach the lower end of the glacier, correspond to the running together of two gelatinous clots (of silicic acid, or glue) containing liquid foam-cells and liquid cell-contents. At the same time the oily foam-walls between the glacier grains become thicker, and then get thinner again through the draining away of the liquid salt solution at the foot of the glacier.

(8) All water, even the purest, contains traces of salt. As the water cools, ice crystals and oily mother liquor separate at short intervals, or periodically. Under the influence of the surface tension, the oily salt solution forms invisible foam-walls, the surface-tension of which decreases as the thickness of the walls and the concentration of the salt solution diminish. Otherwise, as the cooling proceeds, the salt solution becomes continually more concentrated, and the wall thinner. Finally, the concentrated salt solution also freezes to ice and solid salt. The value of the surface tension determines the angles at which three walls meet in a common edge. If three foam-walls meet at equal angles of 120°, the three walls have equal surface tensions, whereas an inclination of 90° means that fluid foam-walls have been formed in contact with old and already solidified ones.

(9) When water containing air freezes, the air, like the salts dissolved in the water, separates out at short intervals, or periodically. The white places in ice, which are those containing these air bubbles, are also the richest in salt.

(10) As water containing salt, but free from air, cools, the periodical separation of ice and salt gives rise, alike in sea ice, in artificial ice, and in glacier ice, to layers of ice containing varying amounts of salt. By pressure or by absorption of radiation (sunlight, electric light, or daylight), the parts of the ice which are rich in salt melt sooner than pure ice.

(11) In sunlight or electric light furrows are formed at the places rich in salt on the surface of sea ice, artificial ice, and glacier ice. (Forel's stripes; Forbes's "dirt bands"; foam-walls of the great foam-cells of the Kjendal Glacier.)

(12) The salt solution formed in sea ice, artificial ice, or glacier ice, through pressure or sunshine, shows, by the hollows which it fills, the forms assumed under the influence of the surface tension by the boundary between the oily salt solution and the water, just before the freezing of the water. As the ice melts, it contracts. Thus in sea ice pressure or absorption of heat radiation causes the formation, in horizontal layers parallel to the frozen surface, of Tyndall's liquefaction figures, vacuous bubbles, ice flowers, and "fir trees" with branches meeting at 120° and 90°, just like those obtained when colloid solutions are evaporated to dryness, or when salt solutions are allowed to crystallise.

In the case of artificial ice which has been frozen in deep prismatic troughs, these liquefaction figures are formed in the diagonal and median planes of the ice block, which were the last parts to freeze, and where the mother liquor had accumulated.

[1] By Prof. G. Quincke, For.Mem.R.S. Paper received at the Royal Society on June 19.

(13) Sea ice and artificial ice break up in sunlight into little hexagonal prisms of clear ice. These suffer mutual displacement the less easily, the thinner are the fine foam-walls (which have now melted again, and which, when the freezing took place, were formed out of oily salt solution, normal to the surface), and the less salt the water contained before freezing.

The purer the water was, the larger are these hexagonal prisms or foam-cells.

(14) The capillary fissures in transparent glacier ice are these fine foam-walls of oily salt solution.

(15) When water containing little salt freezes in deep metal troughs surrounded with strongly cooled brine, the oily salt solution separates in thin layers normal to the surface, and forms bubbles, foam-cells clinging to one another, or—when the oily liquid at low temperatures is very viscous—folds or hollow pipes, which are filled with pure or nearly pure ice, or with air if such were present in the water. The artificial ice is seen to be traversed by many horizontal tubes, normal to the surface, which are specially numerous in the diagonal and median planes of the ice block, where the mother liquor had accumulated. The less salt is contained in the ice, the more transparent are these diagonal and median planes of the artificial ice block.

Illumination with sunlight or daylight causes the appearance of fresh tubes. The ice becomes more cloudy, and subsequently more transparent again.

(16) When water containing air freezes in deep metal troughs, the upper part of the ice block shows horizontal layers consisting alternately of transparent pure ice and of opaque salt-containing ice with numerous air bubbles. The more salt the water contains, the more numerous and the closer are the opaque layers. In sunlight these opaque layers melt more easily than the transparent ones, and furrows are formed on the surface of the opaque ice.

(17) If the ice is allowed to thaw again in a warm room, or is exposed to radiation (daylight), the parts rich in salt melt sooner than those which contain little salt. The tubes of oily salt solution bulge and coil up, and then break up with contraction of volume into spherical bubbles, which may be vacuous or filled with air. The foam-cells exhibit shapes like those of colloids and jellies as they swell or shrink, or those tree-like and branched formations which I have described in the case of the "liquid precipitates" of metallic silicates and cyanides. If the capillary fissures in this opaque ice are filled with very viscous salt solution, or if the oily salt solution forms no continuous foam-cells, it cannot run away. The ice remains white, as glacier ice actually does.

(18) When an ice block thaws under the long-continued action of daylight, there appear, in the diagonal and median planes of the block, bright bands and cloudy bands, which change their shape and position as the duration and intensity of the radiation alter. This is due to the formation of new foam-walls of oily salt solution and the disappearance of old ones. The angles between the foam-walls are also seen to change, which means that the surface tension of these walls is changing. Now as the amount of salt in the diagonal planes increases, and the absorbed radiation diminishes, towards the interior of the ice, and as further the surface tension and viscosity alter with changing concentration and temperature, it follows that the shapes assumed by the oily layers in the interior of the ice under the influence of the surface tension also undergo change.

(19) After thirty to thirty-six hours, the block of artificial ice had melted in the warm room to half its original height (1 metre), and at the foot and warmer places had given way in a pasty mass. In the upper portion, foam-walls had formed in the pure ice, inclined 120° to one another. In these, as in the median layer that had thawed away, melting salt solution ran down for hours. At the warmer places, and at the thin uppermost crust, glacier grains were formed. These were foam-cells, 5 mm. to 10 mm. wide, filled with doubly refracting ice, and separated from one another by singly refracting foam-walls of transparent salt solution. At the junctions of the foam-walls there often lay tetrahedra, bounded by spherical surfaces and filled with transparent liquid.

(20) In the diagonal and median planes of a block of artificial ice (1 metre high) containing a certain very small amount of salt, and exposed to a certain intensity of radiation, there can be formed horizontal closed tubes of pure or nearly pure ice, having rounded heads and sides bulging at places, and filled with liquid salt solution. They slowly swell, slowly break up into separate bubbles, and then slowly pass away. They are first formed low down, at places of high pressure, and afterwards higher up, at places of low pressure.

(21) When distilled water, free from air, was frozen in iron troughs, it was found at a certain temperature or with a certain concentration of the salt solution and the oily foam-wall that the walls and contents of the closed tubes in the lower part of the median plane were for some time coloured yellow. Subsequently this colour disappeared. It was not present when the water was frozen in brass troughs. I believe it was due to ferric oxide, which was differently soluble in the walls and in the liquid inside the foam-cells, and at a higher temperature became insoluble and sank to the bottom.

(22) The phenomena of melting ice depend both on the velocity of freezing and the velocity of thawing. The more rapidly the water freezes, the more numerous are the foam-walls, and the smaller the foam-cells.

(23) Very dilute solutions of different salts, when slowly frozen under similar conditions, give oily layers of varying viscosity and surface tension, or spheres, bubbles, tubes, and foam-walls of varying form. I have shown this with freshly boiled water containing 0·000003 per cent. of NaCl, or equivalent quantities of KCl, K_2CO_3, Na_2SO_4, $CaCl_2$, $MgCl_2$, $Al_2(SO_4)_3$. The water was frozen in prismatic troughs of brass or tin.

(24) During the freezing of water containing 0·0015 per cent. of Na_2SO_4, and also containing air, the air separated at the same time as the mother liquor. The bounding surface between air and almost solidified, very viscous liquid, tends to become as small as possible, and rolls up together to form hollow cylinders, the radii of which are the smaller the more quickly the ice has frozen. The water freezes the more slowly the further it is from the strongly cooled (below 0°) side of the trough. The thin layers forming the walls of the tubes are normal to the solid surface of the side of the trough, or of the transparent mantle of ice which encloses the mother liquor. They frequently form cylindrical or conical tubes, 6 mm. to 12 mm. long, with a whitish skin, and filled with air. Their axes are normal to the surface, and their pointed ends are directed towards the outer side of the ice mantle. At the base of the tubes, which may be 0·5 mm. to 2 mm. wide, there hangs a whitish hollow sphere inside the mother liquor.

(25) On slowly freezing water containing from 0·000014 per cent. to 0·0014 per cent. of Na_2SO_4, or 0·003 per cent. of NaCl, it happens at times that the mother liquor, which is surrounded by a transparent mantle of ice, contains numerous flat crystalline plates of pure ice. These, by their shape, position, and inclination to one another, clearly show that they have been formed from thin oily foam-walls of pure water, which, as the cooling proceeded, have separated from the watery salt solution, and then solidified.

(26) When a test tube, containing boiling distilled water, is plunged into liquid air, the water freezes very quickly to a milky-white mass of ice, with fissures normal to the surface of the glass. If the test-tube with the white ice—the whole being now cooled down to −190°—is plunged into distilled water, it becomes coated on the outside with a thin crust of ice, which can be detached with a knife, and examined in a watch-glass under the polarising microscope. It consists of small glacier grains or foam-cells (0·1 mm. to 0·2 mm. in diameter) the flat walls of which are normal to the cylindrical surface, and are inclined to one another at angles of 120°, 110°, and so on. The interior of each foam-cell contains a crystal of ice, which in the different cells is differently orientated. When the ice in the test-tube is crushed with a steel point, it exhibits a fibrous fracture, with fine fibres normal to the cylindrical surface. Occasionally in the cross-section are seen concentric cylinders composed alternately of transparent and of white ice. The latent heat of the slowly freezing water diminishes the loss of heat, and the velocity of cooling changes. The ice in the transparent layers was frozen

slowly, that in the opaque ones quickly. As this ice thaws in a watch-glass under the polarising microscope, the lumps of quickly frozen white ice exhibit immense numbers of strings—arranged radially alongside one another—of spheres and lenticular masses, 0·01 mm. to 0·02 mm. in thickness, consisting of very nearly pure water. In each sphere there was a vacuous bubble 0·0006 mm. in diameter.

(27) Slowly frozen water showed, on thawing, similar strings of (liquid) spheres and lenticular masses (of larger size, viz. 0·04 mm. to 0·12 mm. diameter), normal to the surface of the block of ice. These spheres and lens-shaped masses had been formed out of solid or hollow cylinders, or long thin cones with local swellings or bulgings. Frequently lens-shaped masses bounded by two spherical surfaces lay in a thin, flat, spiral or warped foam-wall.

(28) The fibres and cylindrical or conical tubes, like the tubes filled with air, were formed out of thin layers of very viscous, oily liquid, which, as the cooling proceeded, separated out, normal to the surface, and under the influence of the surface tension rolled up, being unable, by reason of excessive viscosity, to form spheres or bubbles.

(29) When the thawing has gone on for a long time, fewer foam-walls and larger foam-cells, or glacier grains, appear in the lumps of ice. The strings of liquid spheres, normal to the surface, show an increase in the size of the spheres, caused by the coalescence of the small spheres in the doubly refracting mass of ice into larger ones. An increased amount of salt in the ice assists this coalescence. The tubes or strings of spheres could often be followed continuously through several glacier grains. The partition walls of the glacier grains, when illuminated, often show hundreds of small lens-shaped masses of the same or gradually diminishing size.

(30) By repeated fractional freezing and melting of the ice crystals formed, continually purer and purer ice is obtained, with increasingly large foam-cells or glacier grains. I have, however, not yet succeeded, even by repeated slow freezing, in obtaining ice free from foam-walls or from glacier grains.

(31) A block of transparent ice was cut through, as described by Bottomley, with a loaded wire loop. The loop was of steel wire, or of platinum wire previously heated to redness, and carried 2 kilograms or more. In no case was the plane of section transparent, but always opaque from the presence of solidified foam bubbles of oily salt solution, possessing refracting power different from that of their surroundings.

(32) Each separate glacier grain in artificial ice contains a differently orientated crystal of ice, the optic axis of which is very seldom normal to the surface of the ice. When in natural sea ice the optic axes of the separate crystals in the different grains are found to be normal or parallel to the free surface of the water, the separation of orientated crystals of ice may have been started by the contact-action of ice crystals or snow flakes falling on the surface of the super-cooled water, and swimming thereon in a horizontal position.

(33) The more slowly artificial ice has frozen, and the less salt it contains, the more transparent, rigid, and difficult to cut with a knife it is.

(34) Every block of artificial ice cleaves, on pressure with a steel point, along the diagonal and median planes, in which, as the ice crystals separated out on freezing, the mother liquor became more concentrated through holding the traces of salt dissolved in a continually diminishing volume of liquid.

(35) The planes of easiest cleavage in natural ice crystals (laminated structure, displacement without bending) are due to invisible layers of liquid salt solution which are embedded in the crystals, normal to the optic axis, or often in other positions.

(36) Ice crystals at temperatures below 0° consist of doubly refracting viscous liquid, and are intermediate between the soft crystals of serum albumen and ordinary crystals of quartz, felspar, &c.

(37) At the edge of Tyndall's liquefaction figures, while they are in process of enlarging, or on the bursting of the foam-walls of artificial ice as it melts, one often sees periodic vortex movements. These arise from a periodic capillary spreading out ("Ausbreitung") of the salt solution of the foam-walls at the boundary between pure water and air or vacuum.

(38) Tyndall and Huxley observed in white glacier ice transparent lenticular masses bounded by spherical surfaces. These were foam bubbles of water free from air, which were enclosed in a thin skin of oily salt solution and had solidified while embedded in such a skin.

(39) The blue bands in glacier ice consist of pure ice, while the white bands are composed of ice containing salt and air bubbles. They are formed by the periodical action of solar radiation and by changing pressure, or by the slow descent of the portions rich in salt, or by the slow ascent of air bubbles in the viscous liquid of the glacier ice.

(40) The ice of the snow flakes which fall on the upper part of the glacier becomes fertilised with inorganic salts derived from disintegrated rocks, and is, as it were, hatched out by the sun's rays, forming "névé" or "firn" snow and glacier grains, or foam-cells filled with ice in the glacier proper. The glacier ice travels on, rolling (or "wallowing") slowly downwards as a living river of ice. Its skeleton of liquid salt solution changes the while, and forms new and larger foam-cells, which, at the lower end of the glacier, perish, disappear, and flow away as the water of the glacier stream.

THE BRITISH ASSOCIATION.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY SIR RICHARD C. JEBB, LITT.D., D.C.L., M.P., PRESIDENT OF THE SECTION.

University Education and National Life.

EVERY country has educational problems of its own, intimately dependent on its social and economic conditions. The progressive study of education tends, indeed, towards a certain amount of general agreement on principles. But the crucial difficulties in framing and administering educational measures are very largely difficulties of detail; since an educational system, if it is to be workable, must be more or less accurately adjusted to all the complex circumstances of a given community. As one of those who are now visiting South Africa for the first time, I feel that what I bring with me from England is an interest in education, and some acquaintance with certain phases of it in the United Kingdom; but with regard to the inner nature of the educational questions which are now before this country, I am here to learn from those who can speak with knowledge. In this respect the British Association is doing for me very much what a famous bequest does for those young men whom it sends to Oxford; I am, in fact, a sort of Rhodes scholar from the other end—not subject, happily, to an age limit—who will find here a delightful and instructive opportunity of enlarging his outlook on the world, and more particularly on the field of education.

As usage prescribes that the work of this Section, as of others, should be opened by an Address from the Chair, I have ventured to take a subject suggested by one of the most striking phenomena of our time—the growing importance of that part which Universities seem destined to play in the life of nations.

Among the developments of British intellectual life which marked the Victorian age, none was more remarkable, and none is more important to-day, than the rapid extension of a demand for University education, and the great increase in the number of institutions which supply it. In the year 1832 Oxford and Cambridge were the only Universities south of the Tweed, and their position was then far from satisfactory. Their range of studies was too narrow; their social operation was too limited. Then, by successive reforms, the quality of their teaching was improved, and its scope greatly enlarged; their doors were opened to classes of the community against which they had formerly been closed. But meanwhile the growing desire for higher education—a result of the gradual improvement in elementary and secondary training—was creating new

institutions of various kinds. The earliest of these arose while access to Oxford and Cambridge was still restricted. The University of Durham was established in 1833. In 1836 the University of London, as an examining and degree-giving body, received its first charter. A series of important Colleges, giving education of a University type, arose in the greater towns of England and Wales. The next step was the formation of federal Universities. The Victoria University, in which the Colleges of Manchester, Liverpool and Leeds were associated, received its charter in 1880. The Colleges of Aberystwyth, Bangor, and Cardiff were federated in the University of Wales, which dates from 1893. The latest development has been the institution of the great urban Universities. The foundation of the University of Birmingham hastened an event which other causes had already prepared. The federal Victoria University has been replaced by three independent Universities, those of Manchester, Liverpool and Leeds. Lastly, a charter has recently been granted to the University of Sheffield. Then the University of London has been re-constituted; it is no longer only an Examining Board; it is also a teaching University, comprising a number of recognised schools in and around London. Thus in England and Wales there are now no fewer than ten teaching Universities. Among the newer institutions there are some varieties of type. But, so far as the new Universities in great cities are concerned, it may be said that they are predominantly scientific, and also that they devote special attention to the needs of practical life, professional, industrial and commercial; while at the same time they desire to maintain a high standard of general education. It may be observed that in some points these Universities have taken hints from the four ancient Universities of Scotland—which themselves have lately undergone a process of temperate reform. The Scottish Universities are accessible to every class of the community; and the success with which they have helped to mould the intellectual life of a people traditionally zealous for education renders their example instructive for the younger institutions. With reference to the provision made by the newer Universities for studies bearing on practical life, it should be remarked that much has been done in the same direction by the two older Universities also. At Cambridge, for example, degrees can be taken in Economics and associated branches of Political Science; in Mechanism and Applied Mechanics; and in Agricultural Sciences. It certainly cannot now be said that the old Universities neglect studies which are of direct utility, though they rightly insist that the basis and method of such studies shall be liberal.

In looking back on the general course of this whole movement in England, we find that it has been steady, smooth, and fairly rapid. It has not been due to any spasmodic impulse or artificial propaganda, but has been the result of natural forces operating throughout the nation. Universities, and the training which they give, have come to count for more in our national life as a whole. It should be noted in passing that the missionary movement known as University Extension did not arise in the first instance from spontaneous academic action, but was a response to public appeals from without. It had its origin in memorials addressed to the University of Cambridge, in 1872, by various public bodies; and it was in compliance with those memorials that, in the winter of 1873, the first courses of Extension lectures were organised in the Midlands. Another fact of vital significance in the movement is that it has included ample provision for the higher education of women.

With reference to the present position and prospects of the higher education in South Africa, I tried, before leaving England, to acquaint myself with at least the outlines of the general situation; but it is only with great diffidence that I shall offer a few observations bearing on some of the broader aspects of the question. I trust to be heard with indulgence by those from whom I shall hope to learn more. At any rate, I can truly say that the question seems to me one of the deepest interest and of the gravest importance. Indeed, it does not require much insight or imagination to apprehend the greatness of the issues that are involved.

In the first place, it would be correct, if I am not mistaken, to say that in South Africa at large there is a genuine and a keen desire for efficient education of the highest type. A sound liberal education is desired for all who can profit by it, whatever their future callings are to be. But the practical and immediate need for the organising of the highest teaching is felt, I believe, more particularly in regard to three great professions—the profession of Engineering, in all its branches; the profession of Agriculture (including Forestry); and the profession of Education itself, on which the intellectual future of South Africa must so largely and directly depend. That the interest in the higher instruction is so real must be regarded as the best tribute to the efforts of those able and devoted men who, in various parts of this land, have laboured with dauntless perseverance for the improvement of primary and secondary education. Unstinted gratitude is due also to the University of the Cape of Good Hope. It is acknowledged on all hands that the University, as the chief guardian of learning in South Africa, has done admirable work in maintaining a high standard of general education. Certainly it cannot be regarded as any disparagement of that work if, as seems to be the case, a widespread desire exists that South Africa should possess an institution, or institutions, of University rank, which, besides examining, should also teach. That is a natural progress, which is illustrated by the recent re-constitution of the London University itself. I am not qualified, nor should I desire, to discuss the various difficulties of detail which surround the question of a teaching University. That question is, for South Africa, an eminently practical one; and doubtless it will be solved, possibly at no distant time, by those who are most competent to deal with it. I will only venture to say a few words on some of the more general aspects of the matter.

The primary needs of daily life in a new country make demands for certain forms of higher training—demands which may be unable to wait for the development of anything so complex and costly as a teaching University. It is necessary to provide a training for men who shall be able to supervise the building of houses, the making of roads, bridges, and railways, and to direct skilled labour in various useful arts and handicrafts. The first step in such a provision is to establish technical schools and institutes. Germany is, I suppose, the country where the educational possibilities of the technical school are realised in the amplest measure. In Germany the results of the highest education are systematically brought to bear on all the greater industries. But this highest education is not given only in completely equipped Universities which confer degrees. It is largely given in the institutions known as Technical High Schools. In these schools teaching of a University standard is given, by professors of University rank, in subjects such as Architecture, various branches of Engineering, Chemistry, and General Technical Science. There are, I think, some ten or eleven of these Technical High Schools in Germany. In these institutions the teaching of the special art or science, on its theoretical side, is carried, I believe, to a point as high as could be attained in a University; while on the practical side it is carried beyond the point which in a University would usually be possible. In England we have nothing, I believe, which properly corresponds to the German Technical High School; but we may expect to see some of the functions of such a school included among the functions of the new Universities in our great industrial and commercial towns.

Now Technical Schools or Institutes, which do not reach the level of a German Technical High School, may nevertheless be so planned as to be capable of being further developed as parts of a great teaching University. And the point which I now wish to note is this—that the higher education given in a Technical Institute, which is only such, will not be quite the same as that given in the corresponding department of a teaching University. University education, as such, when it is efficient, has certain characteristics which differentiate it from the training of a specialist, however high the level of the teaching in the special subject may be. Here, however, I pause for a moment to guard against a possible misconception. I am

not suggesting that the specialist training given in a technical institute, though limited, is not an excellent thing in itself; or that, in certain conditions and circumstances, it is not desirable to have such a training, attested by a diploma or certificate, instead of aiming at a University standard and a University degree. Universities themselves recognise this fact. They reserve their degrees for those who have had a University training; but they also grant diplomas for proficiency in certain special branches of knowledge. Cambridge, for instance, gives a diploma in the Science and Practice of Agriculture; and the examinations for the diploma are open to persons who are not members of the University.

But the University training, whatever its subject, ought to give something which the purely specialist training does not give. What do we understand by a University education? What are its distinctive characteristics? The word *Universitas*, as you know, is merely a general term for a corporation, specially applied in the Middle Ages to a body of persons associated for purposes of study, who, by becoming a corporation, acquired certain immunities and privileges. Though a particular University might be strongest in a particular faculty, as Bologna was in Law and Paris in Theology, yet it is a traditional attribute of such a body that several different branches of higher study shall be represented in it. It is among the distinctive advantages of a University that it brings together in one place students—by whom I mean teachers as well as learners—of various subjects. By doing this the University tends to produce a general breadth of intellectual interests and sympathies; it enables the specialist to acquire some sense of the relations between his own pursuit and other pursuits; he is helped to perceive the largeness of knowledge. But, besides bringing together students of various subjects, it is the business of a University to see that each subject shall be studied in such a manner as to afford some general discipline of the mental faculties. In his book on "The Idea of a University" Newman says:—

"This process of training, by which the intellect, instead of being formed or sacrificed to some particular or accidental purpose, some specific trade or profession, or study or science, is disciplined for its own sake, for the perception of its own proper object, and for its own highest culture, is called Liberal Education; and though there is no one in whom it is carried as far as is conceivable, or whose intellect would be a pattern of what intellects should be made, yet there is scarcely anyone but may gain an idea of what real training is, and at least look towards it, and make its true scope and result, not something else, his standard of excellence; and numbers there are who may submit themselves to it and secure it to themselves in good measure. And to set forth the right standard, and to train according to it, and to help forward all students towards it according to their various capacities, this I conceive to be the business of a University."

It may be granted that the function of a University, as Newman here describes it, is not always realised; Universities, like other human institutions, have their failures. But his words truly express the aim and tendency of the best University teaching. It belongs to the spirit of such teaching that it should nourish and sustain ideals; and a University can do nothing better for its sons than that; a vision of the ideal can guard monotony of work from becoming monotony of life. But there is yet another element of University training which must not be left out of account; it is, indeed, among the most vital of all. I mean that informal education which young men give to each other. Many of us, probably, in looking back on our undergraduate days, could say that the society of our contemporaries was not the least powerful of the educational influences which we experienced. The social life of the Colleges at Oxford and Cambridge is a most essential part of the training received there. In considering the questions of the higher education in South Africa it is well to remember that the social intercourse of young students, under conditions such as a great residential University might provide, is an instrument of education which nothing else can replace. And it might be added that such social intercourse is also an excellent thing for the teachers.

The highest education, when it bears its proper fruit, gives not knowledge only, but mental culture. A man may be learned, and yet deficient in culture; that fact is implied by the word "pedantry." "Culture," said Huxley, "certainly means something quite different from learning or technical skill. It implies the possession of an ideal, and the habit of critically estimating the value of things by a theoretic standard." "It is the love of knowledge," says Henry Sidgwick, "the ardour of scientific curiosity, driving us continually to absorb new facts and ideas, to make them our own, and fit them into the living and growing system of our thought; and the trained faculty of doing this, the alert and supple intelligence exercised and continually developed in doing this—it is in these that culture essentially lies." And if this is what culture really means, evidently it cannot be regarded as something superfine—as an intellectual luxury suited only for people who can lead lives of elegant leisure. Education consists in organising the resources of the human being; it seeks to give him powers which shall fit him for his social and physical world. One mark of an uneducated person is that he is embarrassed by any situation to which he is not accustomed. The educated person is able to deal with circumstances in which he has never been placed before; he is so, because he has acquired general conceptions; his imagination, his judgment, his powers of intelligent sympathy have been developed. The mental culture which includes such attributes is of inestimable value in the practical work of life, and especially in work of a pioneer kind. It is precisely in a country which presents new problems, where novel difficulties of all sorts have to be faced, where social and political questions assume complex forms for which experience furnishes no exact parallels, it is precisely there that the largest and best gifts which the higher education can confer are most urgently demanded.

But how is culture, as distinct from mere knowledge, to be attained? The question arises as soon as we turn from the machinery of the higher education to consider its essence, and the general aims which it has in view. Culture cannot be secured by planning courses of study, nor can it be adequately tested by the most ingenious system of examinations. But it would be generally allowed that a University training, if it is really successful, ought to result in giving culture, over and above such knowledge as the student may acquire in his particular branch or branches of study. We all know what Matthew Arnold did, a generation ago, to interpret and diffuse in England his conception of culture. The charm, the humour, and also the earnestness of the essays in which he pleaded that cause render them permanently attractive in themselves, while at the same time they have the historical interest of marking a phase in the progress of English thought and feeling about education. For, indeed, whatever may be the criticisms to which Arnold's treatment of the subject is open in detail, he truly indicated a great national defect; and by leading a multitude of educated persons to realise it, he helped to prepare the way for better things. Dealing with England as it was in the 'sixties, he complained that the bulk of the well-to-do classes were devoid of mental culture—crude in their perceptions, insensible to beauty, and complacently impenetrable to ideas. If, during the last thirty or forty years, there has been a marked improvement, the popular influence of Matthew Arnold's writings may fairly be numbered among the contributory causes, though other and much more potent causes have also been at work. When we examine Arnold's own conception of culture, as expressed in successive essays, we find that it goes through a process of evolution. At first he means by "culture" a knowledge and love of the best literature, ancient and modern, and the influence on mind and manners which flows thence. Then his conception of culture becomes enlarged; it is now no longer solely or mainly æsthetic, but also intellectual; it includes receptivity of new ideas; it is even the passion for "seeing things as they really are." But there is yet a further development. True culture, in his final view, is not only æsthetic and intellectual; it is also moral and spiritual; its aim is, in his

phrase, "the harmonious expansion of all the powers which make the beauty and worth of human nature." But whether the scope which Arnold, at a particular moment, assigned to culture was narrower or wider, the instrument of culture with which he was chiefly concerned was always literature. Culture requires us, he said, to know ourselves and the world; and, as a means to this end, we must "know the best that has been thought and said in the world." By literature, then—as he once said in reply to Huxley—he did not mean merely *belles lettres*; he included the books which record the great results of science. But he insisted mainly on the best poetry and the highest eloquence. In comparing science and literature as general instruments of education, Arnold observed that the power of intellect and knowledge is not the only one that goes to the building-up of human life; there is also the power of conduct and the power of beauty. Literature, he said, serves to bring knowledge into relation with our sense for conduct and our sense for beauty. The greater and more fruitful is the progress of science, the greater is the need for humane letters, to establish and maintain a harmony between the new knowledge and those profound, unchanging instincts of our nature.

It is not surprising that, in the last third of the nineteenth century, Arnold's fascinating advocacy of literature, as the paramount agency of culture, should have incurred some criticism from the standpoint of science and of philosophy. The general drift of this criticism was that the claim which he made for literature, though just in many respects, was carried too far; and also that his conception of intellectual culture was inadequate. As a representative of such criticism, I would take the eminent philosopher whose own definition of culture has already been cited, Henry Sidgwick: for no one, I think, could put more incisively the particular point with which we are here concerned. "Matthew Arnold's method of seeking truth," says Sidgwick, "is a survival from a pre-scientific age. He is a man of letters pure and simple; and often seems quite serenely unconscious of the intellectual limitations of his type." The critic proceeds to enumerate some things which, as he affirms, are "quite alien to the habitual thought of a mere man of letters." They are such as these: "How the crude matter of common experience is reduced to the order and system which constitutes it an object of scientific knowledge; how the precisest possible conceptions are applied in the exact apprehension and analysis of facts, and how by facts thus established and analysed the conceptions in their turn are gradually rectified; how the laws of Nature are ascertained by the combined processes of induction and deduction, provisional assumption and careful verification; how a general hypothesis is used to guide inquiry, and, after due comparison with ascertained particulars, becomes an accepted theory; and how a theory, receiving further confirmation, takes its place finally as an organic part of a vast, living, ever-growing system of knowledge." Sidgwick's conclusion is as follows: "Intellectual culture, at the end of the nineteenth century, must include as its most essential element a scientific habit of mind; and a scientific habit of mind can only be acquired by the methodical study of some part at least of what the human race has come scientifically to know."

There is nothing in that statement to which exception need be taken by the firmest believer in the value of literary education. The more serious and methodical studies of literature demand, in some measure, a scientific habit of mind, in the largest sense of that expression; such a habit is necessary, for instance, in the study of history, in the scientific study of language, and in the "higher criticism." Nor, again, does anyone question that the studies of the natural sciences are instruments of intellectual culture of the highest order. The powers of observation and of reasoning are thereby disciplined in manifold ways; and the scientific habit of mind so formed is in itself an education. To define and describe the modes in which that discipline operates on the mind is a task for the man of science; it could not, of course, be attempted by anyone whose own training has been wholly literary. But there is one fact which may be noted by any intelligent observer. Many of our most eminent teachers of science, and more especially of science in its technical applications, insist on a demand which, in the province of science, is analogous to a demand made in the province of literary study by those who wish such study to be a true instrument of culture. As the latter desire that literature should be a means of educating the student's intelligence and sympathies, so the teachers of science, whether pure or applied, insist on the necessity of cultivating the scientific imagination, of developing a power of initiative in the learner, and of drawing out his inventive faculties. They urge that, in the interests of the technical industries themselves, the great need is for a training which shall be more than technical—which shall be thoroughly scientific. Wherever scientific and technical education attains its highest forms in institutions of University rank, the aim is not merely to form skilled craftsmen, but to produce men who can contribute to the advance of their respective sciences and arts, men who can originate and invent. There is a vast world-competition in scientific progress, on which industrial and commercial progress must ultimately depend; and it is of national importance for every country that it should have men who are not merely expert in things already known, but who can take their places in the forefront of the onward march.

But meanwhile the claims of literary culture, as part of the general higher education, must not be neglected or undervalued. It may be that, in the pre-scientific age, those claims were occasionally stated in a somewhat exaggerated or one-sided manner. But it remains as true as ever that literary studies form an indispensable element of a really liberal education. And the educational value of good literature is all the greater in our day, because the progress of knowledge more and more enforces early specialisation. Good literature tends to preserve the breadth and variety of intellectual interests. It also tends to cultivate the sympathies; it exerts a humanising influence by the clear and beautiful expression of noble thoughts and sentiments; by the contemplation of great actions and great characters; by following the varied development of human life, not only as an evolution governed by certain laws, but also as a drama full of interests which intimately concern us. Moreover, as has well been said, if literature be viewed as one of the fine arts, it is found to be the most altruistic of them all, since it can educate a sensibility for other forms of beauty besides its own. The genius of a Ruskin can quicken our feeling for masterpieces of architecture, sculpture, and painting. Even a very limited study of literature, if it be only of the right quality, may provide permanent springs of refreshment for those whose principal studies and occupations are other than literary. We may recall here some weighty words written by one of the very greatest of modern men of science. "If I had to live my life again," said Charles Darwin, "I would have made it a rule to read some poetry and listen to some music at least once every week. . . . The loss of these tastes is a loss of happiness, and may possibly be injurious to the intellect, and more probably to the moral character, by enfeebling the emotional part of our nature." The same lesson is enforced by John Stuart Mill, in that remarkable passage of his Autobiography where he describes how, while still a youth, he became aware of a serious defect, a great lacuna, in that severe intellectual training which, for him, had commenced in childhood. It was a training from which the influences of imaginative literature had been rigidly excluded. He turned to that literature for mental relief, and found what he wanted in the poetry of Wordsworth. "I had now learned by experience"—this is his comment—"that the passive susceptibilities needed to be cultivated as well as the active capacities, and required to be nourished and enriched as well as guided." Nor is it merely to the happiness and mental well-being of the individual that literature can minister. By rendering his intelligence more flexible, by deepening his humanity, by increasing his power of comprehending others, by fostering worthy ideals, it will add something to his capacity for cooperating with his fellows in every station of life and in every phase of action; it will make him a better citizen, and not only a more sympathetic but also a more efficient member of society.

One of the urgent problems of the higher education in our day is how to secure an adequate measure of literary culture to those students whose primary concern is with scientific and technical pursuits. Some of the younger English Universities, which give degrees in Science, contribute to this purpose by providing certain options in the Science curriculum; that is, a given number of scientific subjects being prescribed for study with a view to the degree of B.Sc., the candidate is allowed to substitute for one of these a subject taken from the Arts curriculum, such, for instance, as the Theory and Practice of Education. This is the case in the University of Wales and in the University of Birmingham; and there are indications, I believe, that this example will be followed elsewhere. Considering how hard and sustained is the work exacted from students of science, pure or applied, it seems important that the subjects from which they are to derive their literary culture should be presented to them, not in a dryasdust fashion, not chiefly as subjects of examination, but rather as sources of recreation and changes of mental activity. From this point of view, for British students of science the best literature of the English language offers unequalled advantages. It may be mentioned that the Board of Education in London is giving particular attention to the place which English literature should hold in the examination of students at the Training Colleges, and has under consideration carefully planned courses of study, in which portions of the best English writers of prose and of verse are prescribed to be read in connection with corresponding periods of English history, it being understood that the study of the literature shall be directed, not to philological or grammatical detail, but to the substance and meaning of the books, and to the leading characteristics of each writer's style. If, on the other hand, the student is to derive his literary culture, wholly or in part, from a foreign literature, ancient or modern, then it will be most desirable that, before leaving school, he should have surmounted the initial difficulties of grammar, and should have learned to read the foreign language with tolerable ease.

When we look at this problem—how to combine the scientific and the literary elements of culture—in the light of existing or prospective conditions in South Africa, it appears natural to suppose that, in a teaching University, the Faculty of Education would be that with which literary studies would be more particularly connected. And if students of practical sciences, such as Engineering and Agriculture, were brought together at the same centre where the Faculty of Education had its seat, then it should not be difficult, without unduly trenching on the time demanded by scientific or technical studies, to provide such students with facilities for some measure of good literary training.

A further subject is necessarily suggested by that with which we have been dealing—I mean the relation of University to Secondary Education; but on that I can only touch very briefly. Before University Education can be widely efficient, it is indispensable that Secondary Education should be fairly well developed and organised. Secondary Education should be intelligent—liberal in spirit—not too much trammelled by the somewhat mechanical uniformity apt to result from working for external examinations, but sufficiently elastic to allow for different aptitudes in the pupils, and to afford scope for the free initiative of able teachers. It is a gain for the continuity of education when a school-leaving examination can be accepted as giving admission to the University. Such an examination must be conducted under the authority of the University; but there is much to be said in favour of the view that, under proper safeguards, the school-teachers should have a part in the examination; always provided that the ultimate control, and the decision in all cases of doubt, shall rest with the University. A system of school-leaving examinations for this country was earnestly advocated, I believe, by Mr. P. A. Barnett, who has achieved such excellent work for the cause of education in Natal. To discuss the advantages or difficulties of such a proposal, as they at present affect South Africa, would demand knowledge which I do not possess; and I must content myself with the expression of a hope that in days to come—perhaps in a not distant future—it may be found practicable to form such a link between the highest education and the grade next below it.

But the limit of time proper for a Chairman's address has now almost been reached. I thank you sincerely for the kindness and patience with which you have heard me. In conclusion, I would only say how entirely I share a conviction which has been expressed by one to whose ability, to whose generous enthusiasm and unflagging efforts the cause of education in this country owes an incalculable debt—I refer to Mr. E. B. Sargant. Like him, I believe that the progress of education in all its grades, from the lowest to the highest, is the agency which, more surely than any other, will conduce to the prosperity and the unity of South Africa. For all workers in that great cause it must be an inspiring thought that they are engaged in promoting the most fundamental and the most far-reaching of national interests. They are endeavouring to secure that the men and women to whom the future of this country belongs shall be equal to their responsibilities and worthy of their inheritance. In that endeavour the sympathies which they carry with them are world-wide. As we come to see, more and more clearly, that the highest education is not only a national but an Imperial concern, there is a growing desire for interchange of counsels and for active cooperation between the educational institutions of the Colonies and those of the Mother Country. The development of education in South Africa will command keen attention, and will be followed by earnest good wishes, not only in England but throughout the British dominions. One of the ideas which are bound up with the history and the traditions of our English public schools and Universities is the idea of efficient work for the State. Those institutions have been largely moulded, from generation to generation, by the aim of ensuring a supply of men qualified to bear a worthy part, either in the government of the nation, or in professional activities which are indispensable to the national welfare. In our own time, and more especially within the last thirty years, one particular aspect of that idea is illustrated by the closer connections which have been formed between the Universities and the higher branches of the Civil Service. The conception of work for the commonweal is in its turn inseparable from loyalty to those ideals of character and conduct by which English life and public policy have been built up. It is by the long and gradual training which such ideals have given that our race has been fitted to grapple with responsibilities which have inevitably grown, both in extent and in complexity, far beyond anything of which our forefathers could have dreamed. That training tends also to national self-knowledge; it makes for a sober estimate of our national qualities and defects; it quickens a national sense of duty to our neighbour. The munificence of a far-sighted statesman has provided that selected youths, whose homes are in this land, and whose life-work may be here, shall go for a while to England, shall breathe the intellectual and social atmosphere of a great English University, and shall learn to judge for themselves of the sources from which the best English traditions have flowed. That is excellent. But it is also most desirable that those traditions should pass as living forces into the higher teaching of South Africa itself, and that their spirit should animate educational institutions the special forms of which have been moulded by local requirements. That, indeed, has been, and is, the fervent wish of men whose labours for South African education have already borne abundant fruit, and are destined to bear yet larger fruit in the future. May those labours prosper, and may that wish be fulfilled! The sooner will come the day when the inhabitants of this country, this country of vast and still indefinite possibilities, will be able to feel, in a sense higher and deeper than citizens of the Roman Empire could conceive, *Cuncti gens una sumus* ("We are all one people"). If the work which lies before us, in this Section of the British Association, should result in contributing anything towards the promotion of those great objects, by helping to elucidate the conditions of further progress, our deliberations will not have been held in vain.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Goldsmiths' College, New Cross, the gift of the Goldsmiths' Company to the University of London, will be opened to-morrow, September 29, by the Earl of Rosebery, K.G., K.T., F.R.S.

ON October 5 Prof. J. W. Judd, C.B., F.R.S., will distribute the medals, prizes, &c., gained by the students of the Royal College of Science. The distribution will take place in the lecture theatre of the Victoria and Albert Museum, South Kensington, at 4 p.m.

THE University of Wisconsin has established a course in chemical engineering. Besides the regular professorial instruction, arrangements have been made for occasional lectures by prominent engineers. The course, which covers four years, includes gas engineering and electrolytic work, as well as other branches of chemical practice.

CONSEQUENT upon the closing of Coopers Hill College, it has been decided that probationers for the Indian Forest Department will take their theoretical course at Oxford. The writer of an article in the *Indian Forester* (July) on the future training of the upper staff of the Indian Forest Department recognises several advantages in the change. But while approval is expressed with the nature of the theoretical course and the experience that will be gained at Oxford, it is pointed out that a practical course in India, as, for instance, at Dehra Dun, would afford greater scope and provide more useful training for the work that is required of Indian forest officers than sending candidates to study forestry practice on the Continent.

THE French and Prussian Governments have recently established a system under which a number of young masters in English secondary schools may be attached for a year to certain secondary schools in their respective countries. The authorities of the foreign Ministries of Public Instruction are most anxious to extend the scheme and to find similar opportunities in suitable English secondary schools for young graduates who will afterwards be employed in their State schools. In the opinion of the Board of Education, the proposal has much to recommend it, and, provided that proper care be exercised in the selection of the candidates and in the arrangements made for their work, it is thought that the presence of such teachers on the staff of a school would add materially to the effectiveness of the modern language teaching. Headmasters who are willing to cooperate and to employ such assistants are requested to communicate with the Director of Special Inquiries and Reports, Board of Education Library, St. Stephen's House, Cannon Row, Westminster, S.W.

THE following free public introductory lectures will be delivered at University College, London, during October. Sir William Ramsay, K.C.B., F.R.S., will lecture on some advances in chemistry; Prof. L. M. Brandin on 'la critique littéraire au xix[e] siècle"; Prof. L. W. Lyde on the teaching of geography to children; Prof. H. S. Foxwell on some aspects of competition in modern business; Prof. F. Mackarness on the origins of Roman Dutch law and its introduction into the British Empire; Prof. E. A. Gardner on architectural sculptures; and Sir John Macdonell on some present directions in legislation. In the department of chemistry of the college several courses of work have been arranged for the ensuing session, viz. Sir William Ramsay, K.C.B., F.R.S., will lecture on the inactive gases of the atmosphere, and on the physics and chemistry of colours; Mr. E. C. Baly will give a course of lectures on spectroscopy and spectrum photography; Mr. J. H. K. Inglis one on recent advances in inorganic chemistry; and Mr. N. T. M. Wilsmore one on electrochemistry. A laboratory course in experimental psychology, consisting of lectures and practical demonstrations, will be given by Mr. W. McDougall, and a course of about thirty lectures on advanced psychology will be delivered by Prof. G. Dawes Hicks. Six lectures, open to the public without payment or ticket, will be given during November by Mr. G. U. Yule on the vital statistics of England and Wales.

THE Marquis of Linlithgow, Secretary for Scotland and vice-president of the Committee of Council on Education in Scotland, is to open the Dunfermline College of Hygiene and Physical Training on Wednesday next, October 4. A correspondent writing to the *Times* says that the establishment of a college of hygiene may be described as an afterthought on the part of the Carnegie trust. When the palatial gymnasium and baths, given to his native city by Mr. Carnegie at a cost of about 40,000*l.*, was approaching completion it attracted the notice of the highest educational a[illegible] in Scotland, who recognised the fitness of the building, with its splendid equipments, to supply what they considered a serious defect in the national provision for education, viz. the instruction of teachers in physical training. After careful consideration the Carnegie trustees, who have charge of the building, agreed to entertain the appeal of the experts to link the local benefaction, of which they are the administrators, with a national service which, while bringing additional distinction to the city, would ensure greater efficiency in the physical training supplied to the local schools. The lady superintendent of athletic instruction has been transformed into the principal of the physical training college, a residence for women students has been acquired, a medical officer has been appointed to devote his whole time to the work of the college, and a course of study has been marked out to extend over two years and to include hygiene, anatomy, physiology, educational and remedial gymnastics on the Swedish system, games, swimming, dancing, &c.

SIR DONALD CURRIE'S letter to the president of Queen's College, Belfast, offering a sum of money under certain conditions for the better equipment of the college was submitted at a private meeting of the executive committee of the college fund on September 22. It was unanimously resolved to convey to Sir Donald Currie the thanks of the committee for his proposal. It was also resolved that in view of the munificent offer of Sir Donald Currie, the committee earnestly appeal to all old students of the college and all who are interested in the promotion of education in Belfast and Ulster to assist in raising the required sum of 20,000*l.* before Christmas. The Rev. Dr. Hamilton, president of Queen's College, writing to the Belfast papers on September 23 in reference to Sir Donald Currie's offer of 20,000*l.*, says that for some time Queen's College has been engaged in a strenuous effort to better its equipments, so as to bring them into line with the scientific and educational advances of our time and with its own growth and development in recent years. This enterprise was inaugurated four years ago, and, notwithstanding adverse circumstances, quickly attained a gratifying success. A sum of more than 30,000*l.* has been raised, by means of which most important additions have been made to the working power of the college. One laboratory has been built and equipped, and the foundation of a second will, it is hoped, be laid before many weeks have passed. If the college succeeds in satisfying the reasonable conditions which Sir Donald Currie lays down, the fund will be increased to 70,000*l.*, and the college will be placed in a financial position such as it never before occupied.

AMONG the calendars and educational directories published during the past few days we notice those of the Northampton Institute at Clerkenwell, the Armstrong College at Newcastle-upon-Tyne, and the Plymouth Education Authority. At the Northampton Institute the following classes are worthy of mention, viz. the day and evening courses in mechanical and electrical engineering, in technical optics, and in horology. In addition to these there are evening courses in technical chemistry and i domestic economy. The Armstrong College was former known as the Durham College of Science. The colle forms an important part of the University of the Nor of England, and the degrees of Durham in science and letters, and its diplomas in engineering, are open students of this Newcastle institution. It may be no that, in addition to the biological laboratories at college, a marine biological laboratory has been at Cullercoats, and by the generosity of the North land Sea Fisheries Committee is available for st The agricultural department has been entrusted

scientific direction of the farm acquired for the purpose of experiment and demonstration by the Northumberland County Council. The new calendar contains full information of all the courses of work arranged for the coming session. The Plymouth directory contains an excellent diagram showing in a graphic manner the arrangements made by the local education authority to coordinate the work in all Plymouth schools. The classes at the school of science and technology make it possible for any workman anxious to acquaint himself with the scientific principles of his calling to do so easily.

In order to facilitate the adoption by secondary schools of systematic courses in geography, the Board of Education has issued a circular indicating in outline the points to which the attention of inspectors will be directed when inspecting classes in this subject. Each school desiring the approval of the Board for its course in geography should be prepared to submit a course providing, first, an outline scheme dealing with the great land and water areas in such a way that on completing the course the pupils shall have gone through the geography of the world; and, secondly, a suitably graded series of exercises connected with the subjects included in the course. The Board lays it down that the aim of the teaching should be to produce a vivid impression of connected facts through considerations, such as those of cause and effect, and the practical bearings of the facts selected. Referring to the exercises, the circular states that these may consist of (a) questions and answers designed to elicit, through causes and consequences, subject-matter for entry in the pupils' note-books; (b) notes and diagrams which should include worked-out problems together with original maps and plans; (c) mapping; and (d) field work, excursions, factory visits, &c. Suggestions for a four-year course in geography, together with an outline plan for preliminary instruction, are also given. The work suggested for the preliminary instruction as suitable for children from eight to twelve, and the statement of what these pupils should be expected to know before entering upon the four-years' course, presume a standard of attainment which the Board can scarcely expect to be realised at present. The knowledge of physiography, for instance, to be expected of these young people would be a credit to students several years older. As so few teachers of geography understand what is meant by the scientific study of their subject, it would have been an advantage if the instructions as to the practical work to be done could have been made more explicit. The circular refers to "worked-out problems," but it might with advantage have included a few typical examples of the problems required. The real difficulty will be to find teachers capable of acting in the spirit of the suggestions made by the Board; but it is something for them to have a method indicated which not only is sound in principle, but is being put into practice here and there. The circular is a decided step in advance, and brings nearer the time when scientific instruction in geography will be general in schools of all grades.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 8.—"The Pharmacology of Indaconitine and Bikhaconitine." By Dr. J. Theodore **Cash,** F.R.S., and Prof. Wyndham R. **Dunstan,** F.R.S.

The present paper deals with the physiological action of two new "aconitines," which have been isolated at the Imperial Institute from two varieties of Indian aconite. One is an alkaloid, which has been named indaconitine. It was found in the roots of the Indian aconite, called by Bruhl *Aconitum napellus*, var. *hians*, since identified by Stapf as a new species which has received the name of *Aconitum chasmanthum*. The other alkaloid has been named "bikhaconitine," being derived from one of the highly poisonous forms of aconite known in India under the vernacular name of "Bikh." This aconite was named by Bruhl *Aconitum ferox*, var. *spicatum*, but has been renamed *Aconitum spicatum* by Stapf, who regards it as a distinct species.

Results of experiments with these two substances are summarised as follows:—

The two aconitines, indaconitine and bikhaconitine, agree in their qualitative effects with the other alkaloids of this series, aconitine, japaconitine, and pseudaconitine, which have been dealt with in our previous papers.

The toxicity of indaconitine is less than that of bikhaconitine towards warm-blooded animals; in this respect the former stands very near to the aconitine of *A. napellus*, whilst the latter, being somewhat stronger than japaconitine, is to be referred to a position between this alkaloid and pseudaconitine from forms of *A. ferox*, which is much the most active of the series.

The depression of the respiratory function by indaconitine is less than that produced by bikhaconitine, and to this the greater toxicity of the latter is referable. Repeated doses of alkaloids administered at regular intervals and in similar fractional proportions of the lethal dose are followed by a more marked toxic effect when bikhaconitine is administered rather than indaconitine. Towards frogs the toxicity of the two alkaloids under discussion is practically equal; bikhaconitine is more active than indaconitine in reducing the respiratory activity. On the other hand, it is somewhat less active in abolishing the excitability of muscular and intramuscular motor nervous tissue (immersion experiments), and in reducing the ability of the muscle-nerve preparation poisoned *in situ* for the performance of work sufficient to cause fatigue. The local effect of the two aconitines when applied to the skin by inunction is equal and similar to that of the aconitines already considered.

Indaconitine and bikhaconitine may therefore be substituted for aconitine and pseudaconitine for internal use, indaconitine being administrable in the same dose as aconitine (from *A. napellus*) and bikhaconitine in proportion of 0·75 of the unit dose of the former, whilst for local application they may be used as constituents of ointments in similar proportions to aconitine.

Pseudaconine from Pseudaconitine and Bikhaconitine.

The action of these is, towards frogs, identical. Their toxicity appears to be practically equal and their effect generally similar to that of aconine (from aconitine). Their action is in the main curari-like in character.

"On the Physiological Activity of Substances Indirectly Related to Adrenalin." By H. D. **Dakin.** Communicated by Prof. E. H. Starling, F.R.S.

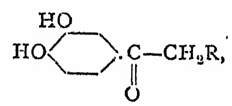
The following deductions are made provisionally, until further experimental evidence is available:—

(1) It appears that the catechol nucleus is essential for the production of physiologically active substances of the type of adrenalin.

(2) It is of importance that the hydrogen atoms of both hydroxyl groups in the catechol nucleus be unsubstituted.

(3) An alkyl group of low molecular weight (*e.g.* methyl, ethyl) attached to the nitrogen tends to produce a much more active substance than when an aromatic group is attached, whilst derivatives of piperidine, heptylamine, and benzylamine occupy an intermediate position.

(4) The reduction of ketonic bases of the type



where R is a simple aliphatic group, results in the production of bases with enormously increased physiological activity.

(5) In the substances examined there appears to be a connection between chemical instability and physiological activity, and *vice versâ*.

July 8.—"An Experimental Inquiry into the Nature of the Substance in Serum which influences Phagocytosis." By Dr. George **Dean.** Communicated by Prof. J. Rose Bradford, F.R.S.

The author's conclusions are as follows:—

(1) As has been shown by a number of workers, *e.g.* Denys, Metchnikoff, Savtschenko, Levaditi and others, there is produced in the blood serum of animals actively immunised by bacterial injections a specific immune substance which has among its properties that of preparing the microbe for phagocytosis.

(2) This immune substance is thermostable, resisting a temperature of 60° C. for several hours.

(3) In normal serum there is present a substance having a similar action and which also resists a temperature of 60° C. for hours, and may persist in the serum of the horse for years.

(4) The experiments recorded in this paper tend to confirm the idea that the substances are identical, *i.e.* that in normal serum there is present a small amount of the immune substance having the property of preparing the microbes for phagocytosis.

(5) Cocci fully occupied by the substance from heated immune serum when passed through fresh normal serum do not remove the substance from normal serum, whereas fresh cocci remove a large part of it.

(6) The converse of the above is also true, viz. that cocci fully occupied by the substance from normal serum do not remove the substance from immune serum, whereas fresh cocci do.

(7) The thermostable substance in normal serum is no doubt identical with the "fixateur" or "substance sensibilisatrice" of the French school and with Wright and Douglas's "opsonin."

Seeing that the terms "fixateur" and "substance sensibilisatrice" which have been employed by Metchnikoff's school to include the property of preparing the microbes for phagocytosis are used to designate a number of other properties of immune serum, it may be convenient to adopt Wright and Douglas's term of "opsonin" for the particular property in question. The only danger attached to such a course is that one might be led to regard the "opsonin" as actually a different substance, and not merely a property of immune serum.

PARIS.

Academy of Sciences, September 18.—M. Troost in the chair.—Preliminary note on the total eclipse of the sun of August 30 at Burgos: H. **Deslandres.** Details are given of the instruments set up and the observations attempted. Owing to clouds, the second and third contacts could not be observed. The corona was seen for a minute about the middle of totality. M. Fabry succeeded in making a photometric measurement of the total light of the corona, and an observation of the brightness of one of its points. M. Bernard also was successful in some photometric observations, and M. d'Azambuja in measurements of the heat spectrum of the corona. Details of the work will be published later.—Observation of the eclipse of August 30: H. **Andoyer.** The apparatus was installed at El-Arrouch, 32 kilometres from Philippeville, and the weather was very favourable. The object was to obtain as many direct photographs as possible. Forty-four were obtained, eleven during totality.—Observation of the solar eclipse of August 30 at Athens: D. **Eginitis.** The observations were made under good atmospheric conditions.—On the isolation of terbium: G. **Urbain.** In a preceding communication the author has described the separation of a rare earth characterised by a single absorption band $\lambda=488$, corresponding to an element named $Z\delta$ by M. Lecocq de Boisbaudran. This has been submitted to a long series of further fractionations, first as a double nitrate with nickel, and afterwards by precipitation with ammonia. The final product was 7 grams of an earth apparently homogeneous, for which the author proposes to reserve the name of terbium. The principal bands in the absorption spectrum are given, and the atomic weight, 159.2 (O=16).

NEW SOUTH WALES.

Linnean Society, July 26.—Mr. T. Steel, president, in the chair.—On dimorphism in the female of *Ischnura heterosticta*, Burm. (Neuroptera: Odonata): R. J. **Tillyard.** In February last, at Cook's River, about a dozen beautifully coloured examples of the pretty little dragon-fly, *Ischnura heterosticta*, Burm., which appeared to be males, were captured, together with half-a-dozen females of the ordinary dull blackish type. On examination it was found that, with the exception of three, all the supposed males were in reality a second form of female (form B) closely resembling the male. It is intermediate in shape between the male and the typical female (form A), the abdomen being thicker than in the male, but with the tip distinctly enlarged; while in colouring it almost exactly resembles the male, but bears not the slightest resemblance to the typical female. Both forms, however, possess the pale pterostigma on the forewing, whereas in the male this is black.—Notes on the older Tertiary foraminiferal rocks on the west coast of Santo, New Hebrides: F. **Chapman.** The examination of the oldest sedimentary rocks seen and collected by Mr. Mawson in the Island of Santo proves them to be of Miocene age (Aquitanian and Burdigalian). A point of particular interest brought out by the present investigations is the association of Lepidocyclina with the excentric forms of Miogypsina in the New Hebrides. From this it appears that faunas, distinct in the European area, were living together in the New Hebrides Miocene sea. A similar association of species occurs here as in the Miocene limestones of Christmas Island, and also of Madoura, and other parts of the Dutch East Indies, with which the New Hebrides marine area was most probably connected when these fossiliferous beach and shallow-water deposits were laid down.—On the occurrence of a bed of fossiliferous tuff and lavas between the Silurian and Middle Devonian at Cavan, Yass, N.S.W., similar in age and character to the Snowy River porphyries of Victoria: A. J. **Shearsby.**—The *rôle* of agglutination in immunity: R. Greig **Smith.** The research has shown that (1) normal typhoid bacteria are incapable of being absorbed by the leucocytes when these have been freed from adhering serum; (2) typhoid bacteria, when treated with active agglutinating serum which has been heated to destroy the opsonins, are agglutinated and are then englobed by the leucocytes; (3) typhoid bacteria which have been grown in agglutinating serum, heated or not heated, are also absorbed; (4) while active agglutinating serum prepares the microbes for inception by the phagocytes, the so-called chemical agglutinating substances do not possess this property; and (5) the *rôle* of agglutinin is, therefore, to coat the bacteria with a precipitate which is positively chemotactic towards the leucocytes; and thus, by facilitating the absorption of the microbes, agglutination plays an active part in immunity.

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THURSDAY, OCTOBER 5, 1905.

MODERN GEOLOGISTS AND THE "OLD MASTERS."

Ice or Water. Another Appeal to Induction from the Scholastic Methods of Modern Geology. By Sir Henry H. Howorth, K.C.I.E., D.C.L., F.R.S., V.P.S.A., F.G.S. Vol. i. Pp. xlvi+536. Vol. ii. Pp. viii+498. (London: Longmans and Co., 1905.) Price 32*s.* net.

THE two volumes before us must be regarded as parts of a complete work in which the author has set himself the task of disproving the usually accepted glacial theory. As he himself says in his preface, "the two volumes now published contain a large part of, though not all, my supplementary arguments against the glacial theory; a portion being still reserved for a succeeding volume which will also contain an enlarged presentation and justification of the theory I substituted for it in my 'Glacial Nightmare,' namely, the diluvial theory."

In the volumes under review the subject-matter may be considered under three heads:—(1) the theories which have been proposed to account for Glacial periods; (2) the efficiency of water as an agent of erosion; (3) the capacity of ice to produce the effects which have been assigned to it by modern geologists.

(1) *Theories of an Ice Age.*—The four opening chapters of the first volume are devoted to a criticism of the various theories, astronomical and geographical, which have been put forward in attempts to solve the problem of the Great Ice Age and of former periods of glaciation. Sir Henry is ever skilful in detecting the weak points in his opponents' armour, and here, as in his book on the "Glacial Nightmare," he has an imposing array of objections raised by others and himself to the various explanations which have been offered.

Our present inability to offer any adequate explanation of the Glacial period seems to be largely recognised; as Prof. Chamberlin has said, "The riddle remains to be read." This grieves the author greatly, perhaps unduly.

"It is not encouraging," he says, "to read of a succession of failures by men of parts and ingenuity in futile efforts to solve what is apparently an insoluble problem; to measure the waste of thought and time and oil involved in these efforts of the geological Sisyphus to roll the glacial snowball on to some stable foothold, and to see it roll down the hill in every case into the abyss where so many scientific hopes and efforts lie buried."

But is the waste so complete as the author seems to imply? Though the riddle is not yet read, the number of facts which have been garnered during the process of testing the inadequate explanations remain for use when seeking the correct solution, and many a minor point has already been settled.

The occurrence of Glacial periods is not the only climatic problem to which the geologist is without clue. We have not yet explained the existence of beds containing rich floras in Greenland. To the ordinary geologist the evidence for a Glacial period is as strong as that for the former occurrence of warmer conditions in Greenland, and he is hardly likely to reject the evidence in the former case any more than in the latter, simply because he has not yet arrived at an adequate explanation of the phenomena.

(2) *The Efficiency of Water as an Agent of Erosion.*—The author devotes several chapters to a discussion of the potency of the various agents of subaërial and marine erosion under existing conditions, and refuses to recognise the efficiency of these agents to do the work claimed for them by the great number of living geologists. He supports his arguments by a large number of quotations from various writers, ancient and modern, great and small. But we look in vain for any recognition of the principles of erosion which were laid down by G. K. Gilbert in his "Geology of the Henry Mountains," and form the basis of modern writings on erosion. He quotes Mr. Harker's paper on the subaërial denudation of Skye (*Geol. Mag.*, 1899, p. 485) to show that in that district "the agents of atmospheric degradation, erosion and transportation, are at the present time almost wholly inoperative," but ignores that writer's statement concerning the great erosion of the district in Tertiary times. Sir Henry, in fact, does not seem to have recognised the importance of the "base-line of erosion" as one of the controlling factors in the sculpture of a district, and this vitiates many of the arguments advanced in this section of the book.

But there is much in this section that is suggestive, especially the portions dealing with the effects of earth-movement and fracture in the production of valleys. In the "heroic age" of geology too much influence was undoubtedly assigned to these effects in accounting for valley-formation, and one cannot but feel that with the swing of the pendulum, and owing to the importance which geologists now attach, and rightly attach, to agents of erosion, the influence of movement accompanied by fracture, at any rate as an indirect factor, has been unduly minimised.

(3) *The Capacity of Ice to Produce the Effects Assigned to it.*—In the two concluding chapters of vol. i. and in the greater part of vol. ii., Sir Henry is directly at issue with the modern geologists, for in the majority of the phenomena which have been appealed to in support of the operations of ice he refuses to see any signs of ice-work. Notwithstanding the ingenuity with which he argues, we cannot see that he makes out a case. The Glacial period has been established as the result of cumulative evidence, and although there are many differences of opinion on minor points, geologists are agreed as to the occurrence of such a period in late Tertiary times in consequence of what most of them consider to be overwhelming evidence.

Here we must insert a word concerning the author's "old masters." In vol. i., p. 213, he takes his stand "with the old masters, Hopkins and Whewell, Conybeare, Sedgwick and Murchison. These men knew something more than geology; they were mathematicians and physicists as well." Again, on p. 460 he says:—"I do not hesitate myself to confess, and to be proud of the confession, that I

believe in the old men rather than in the new." It is true that in these cases he is referring to special points, but again and again one cannot but feel in reading the book that the writer pays undue regard for authority, without considering that his "old masters" were not acquainted with all the facts which we now possess, and that they themselves changed their views. Sedgwick, for instance, came to believe in an Ice age. Moreover, if these were old masters, so were Hutton and Playfair, Lyell and Buckland, whose views are not always so palatable to the author. It may be remarked, also, that a knowledge of mathematics and physics was not confined to the geologists of those days. One of the most ardent of the existing advocates of ice-erosion, concerning whose paper on ice action in Skye (*Trans. Roy. Soc. Edin.*, vol. xl., 1901) Sir Henry is silent in these two volumes, was a high wrangler, and took a first class in physics at Cambridge.

The theory of an Ice age was largely put forward owing to the existence of rounded and striated rock-surfaces and scratched and polished boulders. These resemble similar productions of modern ice to such a degree that the geologist has no more hesitation in referring them to ice-action than he has to assign the formation of the pebbles of a river to stream-action. The inference drawn from the existence of these phenomena has been supported by a host of other observations, biological as well as physical, and if Sir Henry should succeed in disproving the existence of an Ice age he will also break down the essential principle of geology, "that like effects imply like causes."

It would be impossible in a brief article to discuss all the questions raised in this part of the work. We must content ourselves with a few observations. Though reference is made now and again to the Greenland ice and to the ice masses of Spitsbergen, it is the glaciers of the alpine type to which most frequent appeal is made. To this we shall recur, but in the meanwhile would invite the author's attention to yet another treatise concerning which he is silent, where another type of ice work is described, namely, I. C. Russell's volume on the Malaspina Glacier (thirteenth annual report of the U.S. Geological Survey).

When describing the Till or Boulder-clay, the author quotes a description of it by Prof. James Geikie, and goes on to observe, "this being without question the most typical of so-called glacial deposit, it is a remarkable fact that no such deposit is now being made, so far as we know, by land-ice anywhere." He must have overlooked a passage in a paper to which he elsewhere refers, by Messrs. Garwood and Gregory, on the glacial geology of Spitsbergen (*Quart. Journ. Geol. Soc.*, vol. liv.). They say:—

"On the broad plain at the foot of Booming Glacier we found some square miles of a tough mud containing boulders and pebbles; it only needed to be dried and hardened to form an ideal Boulder Clay. Clearly this deposit had been laid down by land-ice."

The author objects to the sharp line which is drawn by many geologists to show the margin of the ice at its period of maximum extension, and denies the existence of any evidence for this, arguing that the Boulder-clay, the masses of gravel and loam, and the loess are genetically connected. Of this we shall doubtless hear more when the third volume appears.

Much is naturally made of the conflict of opinion among geologists concerning the occurrence of inter-Glacial periods, and the relative importance of land-ice and floating-ice in producing the phenomena generally taken to indicate the occurrence of a Glacial period. These questions are certainly not settled to everyone's satisfaction, but they in no way invalidate the conclusions which have been drawn as to the existence of an Ice age.

Though we do not agree with the author in his main conclusions put forward in this section of the work, we must admit that much that he writes is worthy of consideration, even though his views seem exaggerated. For instance, he argues that much of the material forming the drifts was broken up prior to the so-called Ice age, and this we believe to be true, even though the breakage did not occur in the manner advocated elsewhere by the author; but if true, it invalidates the appeal to modern Alpine glaciers to prove the inadequacy of ice as an erosive agent. The loose materials ready to hand at the beginning of Glacial times would supply the ice with the tools for rasping and grinding. As that material became comminuted, unless new material was supplied in abundance, the ice would become less effective as an eroder. Also ice, like water, has a base line of erosion beneath which it cannot work. This line may have been reached in the case of Alpine glaciers, and the supply of material to the sole have been also largely diminished, in which case one can no more argue from what Alpine glaciers are now doing as to the effects of land ice in the Glacial period than one can explain the cañons of the Colorado by reference to a little stream which has established its base level.

Throughout the work much has been made of the conflicting views of geologists as to the details of ice action. Sir Henry is obviously greatly impressed with the fact that in the long and arduous attempt to unravel the Gordian knot the skein sometimes seems to have become hopelessly twisted; but he who carefully studies the process of disentanglement sees that, notwithstanding the many kinks, the tangle is becoming less. The author, impatient of the slow process, has elsewhere attempted to cut the knot, and will evidently give reasons for this act in the third volume. We fear that the attempt will not be regarded as successful, either by the "ultra-glacialists" or by geologists in general.

We cannot recommend the book to geological babes and sucklings, but it will well repay perusal by the advanced reader. He will forgive the "energetic adjectives and adverbs," which are hardly necessary to a calm and dispassionate discussion, on reading the author's frank apology in the preface. The store of facts collected in the book is of the utmost value

to the student of glacial geology, though we wish that references to the original memoirs had been in all cases added. There are, as we have tried to show, many valuable criticisms and suggestions contained in the work. Lastly, it will prove a useful intellectual exercise to weigh the author's arguments in the balance. For these reasons we believe that readers who have an extensive acquaintance with the facts and principles of geology will read the book with profit—and with pleasure. J. E. M.

PHYSICAL CHEMISTRY.

Theoretical Chemistry. By Prof. Walther Nernst. Revised in accordance with the fourth German edition. Pp. xxiv+771. (London: Macmillan and Co., Ltd., 1905.) 15s. net.

THE fact that three further editions of the German text of Nernst's well known treatise on theoretical chemistry have been called for since the appearance of the original in 1893, affords ample testimony to its intrinsic merits. An English translation of the first edition by Prof. C. S. Palmer appeared in 1895, and this, until now, has been the only English version.

During the last ten years much valuable work has been carried out in the province of physical chemistry, and the publishers have recognised the necessity of bringing the English edition up to date. With that object Dr. R. A. Lehfeldt has translated the whole of the new matter contained in the fourth German edition and has revised certain parts of the original translation.

It has been the reviewer's experience to hear the original translation adversely commented upon, and it is perhaps to be regretted that the bulk of the old text remains as it was in the first edition. After careful perusal of the work, it is indeed difficult to suppress the feeling that a better result would have been attained by an entirely new translation of the fourth German edition.

Two new chapters in the work under review deal with "The Atomistic Theory of Electricity" and "The Metallic State." In the first of these an account is given of the electron theory and of the phenomena of ionisation and electric conduction in gases. In the second the nature of the metallic condition is discussed on the basis of results which have been obtained by the study of the freezing point curves and of the electrical conductivity of mixtures of metals. These chapters form very interesting reading, although, of course, it has not been possible within the compass of seventeen pages to give more than the briefest outline.

The space given to electro-chemistry has been extended from 26 to 46 pages, and the exposition of the subject-matter greatly improved. The application of thermodynamics and of the osmotic theory to electrochemical systems is now treated in separate chapters, and many new observations bearing on the theory of electrolysis have been incorporated.

It is not possible to mention more than a few of the alterations and additions which have been made in the text generally. One notes with pleasure that the somewhat abstruse exposition of energy relationships in the introductory chapter has been made more lucid. The discovery of the inert gases of the argon series has led to much discussion of late years in reference to the periodic classification of the elements, and these recent views are summarised in the chapter on the atomic theory.

Other important new sections deal with Werner's theory of molecular compounds, catalysis, the mechanism of autoxidation processes, tautomerism, and the kinetics of heterogeneous systems. The view that tautomerism is due to the co-existence in dynamic equilibrium of mutually transformable isomeric substances seems to be very probable in the light of recent work. In this connection the interesting observations of Hantzsch on the transformation of the tautomeric forms of nitrophenylmethane and similar bodies are recorded, but one looks in vain for any reference to Lowry's investigations on dynamic isomerism. In reference to the kinetics of heterogeneous systems and the mechanism of chemical change, it is now recognised that many gaseous reactions, usually regarded as taking place in a single phase, are possibly examples of changes essentially conditioned by phenomena at a boundary surface. The rate at which arsine or phosphine decomposes is in accord with the formula for a unimolecular change, but this agreement really affords no conclusive argument with reference to the mechanism of the change. The measured rate of change has possibly nothing whatever to do with the chemical change involved, but merely with a physical change at the surface of the containing vessel. In a third edition reference should be made to this in the section dealing with the mechanism of reactions on pp. 562–564.

Of necessity, much new work has had to be left unmentioned in the new edition, but the author is to be congratulated on the large amount of new matter which he has been able to introduce without appreciable alteration in the size of the volume. With the issue of this second edition one may confidently anticipate that Nernst's book will still maintain its position as one of the classics of theoretical chemistry.

H. M. D.

STOKES'S MATHEMATICAL AND PHYSICAL PAPERS.

Mathematical and Physical Papers by the late Sir George Gabriel Stokes, Bart. Vol. v. Pp. xxv+370. (Cambridge: The University Press, 1905.) Price 15s.

THE speedy completion of the reprint of Stokes's papers is matter of congratulation to the distinguished editor, to the Cambridge Press, and to all students of mathematical physics. The general character of the contents of this concluding instalment is sufficiently described in the following extract from Prof. Larmor's preface:—

"It will be observed that the present volume represents the period in which Sir George Stokes' scientific activities were mainly expended in the work of the Royal Society and of public Scientific Committees,

and in giving assistance to the investigations of others. The volume thus consists largely of additions and notes originally appended to memoirs by other authors."

Hence, although we meet abundant evidence of Stokes's constant occupation with scientific subjects, and of the characteristic generosity with which he placed his powers at the service of others, we miss something of the more spontaneous activity which characterised his earlier period. We find various proofs, however, that the subjects which had first fascinated him were never long absent from his thoughts; and occasionally they receive a flash of unexpected illumination. We may cite the various notes on water-waves, the brilliant little paper on semi-convergent series, and the admirable interpretation of Prof. Hele-Shaw's experiments on the flow of a viscous liquid between parallel plates. We have also a record of the keen interest which in the last few years of his life he took in the subject of Röntgen rays. The lecture (p. 256) which he gave to the Manchester Literary and Philosophical Society in 1896 was written out (with the help of reporters' notes) *after* delivery; bright and genial as it is, it gives no adequate idea of the buoyant freshness and vivacity which characterised the oral exposition.

The volume includes, by a happy determination, a collection of the papers set by Stokes in the mathematical tripos, and in the old Smith's Prize examination. It is well known that through this unusual channel several important scientific results were first made known to the world; for example, the notion of group-velocity, and the famous "Stokes's Theorem," respecting which we have an interesting historical note by Prof. Larmor. We suspect that a mathematical antiquarian might make further interesting "finds." If we are not mistaken, we detect prior publications of a remarkable theorem relating to the infinite product for sin x, and of a definite integral property of Bessel's functions, which are usually attributed to Weierstrass and to H. Weber respectively. Of course, no one, least of all Stokes himself, would attach much importance to the question of priority under these conditions; but such instances are of interest as showing, in unexpected directions, the singular vigour and independence of Stokes's mind.

The Royal Society obituary notice, with its authoritative appreciation of Stokes's scientific researches by one of his keenest admirers and disciples, forms a fitting accompaniment to this monumental publication. The volume is further adorned by an excellent photograph by Mrs. Myers, of date 1892.

The scientific world will await with great interest the publication of the "volume of biographical character, to be occupied in part by a selection from Sir George Stokes's voluminous scientific correspondence, including some unpublished manuscript material," which is promised in the preface. The great energy with which Prof. Larmor has discharged his present honourable task justifies the hope that we shall not have to wait too long for the proposed supplement.

H. L.

OUR BOOK SHELF.

Notes on the Drawings for Sowerby's "English Botany." By F. N. A. Garry. Reprinted from the *Journal of Botany*, 1904–5. Pp. 276. (London: West, Newman and Co., 1905.) Price 6*s*.

The series of volumes known as "English Botany" was begun in 1790 by James Sowerby, the botanic artist, who engaged Dr. James Edward Smith, the possessor of the Linnean collections and founder of the Linnean Society, to describe the plants depicted by him. At first the name of the draughtsman only appeared on the title-page, but in 1795 a preface to the fourth volume by Smith acknowledged his authorship, and he was much annoyed in after years by "the flippancy with which everybody quotes "Sowerby," whom they know merely as the delineator of these plates, without adverting to the information of the work, or the name of the author." The artist and those who followed him preserved the original drawings of the phanerogams and vascular cryptogams, which ultimately came into the possession of the trustees of the British Museum, and are now in the department of botany. Here are to be found the drawings, with impressions from the original plates, and also from the third recast edition, laid down side by side on the same sheets. The drawings (which had been submitted to Smith for his criticism and his text which accompanied them) bear many notes and directions to the engraver, which are of great interest as showing not only the state of botany at the time, but mentioning the numerous contributors of plants to the work and its supplement. Mr. Garry has done excellent service in the laborious task of transcribing and editing these notes, which can now be read by those who have not seen the originals themselves. Turning over these pages, the writer is reminded of the days when, more than thirty years ago, he first made acquaintance with the drawings in the old rooms of the department at Bloomsbury, recalling the charm they possess for all who care for the history of the native plants of Great Britain.

Without going into detail it would be impossible to set out many most interesting items which are to be found in the pages of this modest reprint from the two years' supplements to the journal in which they made their first appearance. We have here glimpses of a big book in the making, which extended in the first instance to thirty-six volumes and closed in 1814 with a general index. Further discoveries and greater discrimination of critical forms induced the beginning of a supplement in 1831, which died out in 1866 in its fifth volume; the text in these later volumes was by many hands, amongst them the most active and critical of the botanists of the day. These last plates are now in the Fielding herbarium at Oxford, whence they were borrowed by the author so as to complete his work.

B. D. J.

A Text-book of Chemical Arithmetic. By Horace L. Wells. Pp. vii+166. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 5*s*. 6*d*. net.

In the preface it is stated that this book "is designed especially for the use of students of quantitative analysis, many of whom, even after having taken extensive courses in higher mathematics, show little ability to solve simple chemical problems. Certain portions of the work are suitable also for the use of those who are studying elementary chemistry." It appears, therefore, that an American professor is no better off than his English cousin in this matter of student arithmetic The difficulty is two-fold. In

the first place, the student has never been taught arithmetic in relation to actual measurements, but has been exercised in fictitious transactions with oranges and nuts, rods, poles or perches, and vats into which liquor flows at the rate of so many gallons a minute and out of which it flows (notwithstanding the dwindling pressure) at another exact and steady rate. The result is that the student has no idea of the relation of magnitude to measurement, and no opinion whatever on the subject of significant figures; he cannot use logarithms or a slide-rule, and is unpractised in contracted methods of computation. In the second place, it is very likely that he has no sound idea of proportion. Given a student in this condition —and it is still the common case—the teaching of what is called chemical arithmetic becomes a serious part of the duties of a teacher of chemistry. The fundamental numbers of chemistry—the atomic weights—are proportional numbers, and it may be said without exaggeration that the failure to realise this and the inability to see how proportional numbers may be used for the calculation of absolute weights, locate the real *pons asinorum* of elementary chemistry.

In these circumstances any well considered attempt to expound the elements of chemical arithmetic is to be welcomed, and Prof. Wells has certainly succeeded in writing something on the subject which is likely to be very useful. He does not quite descend to the meanest capacity, but he deals in a very clear way with the meaning of figures and the limits of accuracy in measurement and computation. He also gives a good survey of the chief types of chemical problems, including all kinds of analyses and the corrections of gas volumes. Great pains are taken to impress the student with the importance of using common sense and judgment whilst performing arithmetical operations, and to this end set rules and stereotyped formulæ are avoided. An appendix to the book contains tables, including a well printed set of five-figure logarithms. Altogether the work is one that may be warmly recommended to the notice of English teachers.

A. S.

The Physics and Chemistry of Mining. By T. H. Byrom. Pp. xii+160. (London: Crosby Lockwood and Son, 1905.) Price 3s. 6d. net.

THIS elementary class-book supplies information required for such examinations as the Board of Education principles of mining, stage i. The idea is a good one, as the principles of pure science upon which mining practice is based are apt to receive scant attention in mining classes. The author, who is chemist to an important colliery company, has, as lecturer at the Wigan Technical College, become acquainted with the needs of students, and he gives in concise form much useful information regarding the atmosphere, the laws relating to the behaviour of gases, the diffusion of gases, the composition of the atmosphere, water, carbon, fire-damp, combustion, coal dust, explosives, the composition of coals, the analysis of coal, the strata adjoining the Coal-measures, magnetism and electricity. The language is simple, and chemical symbols are sparingly used. There is, however, a want of uniformity in nomenclature that might confuse the beginner. The terms "carbonate of magnesium" (p. 96) and "magnesia carbonate" (p. 125), "iron oxide and aluminia" (p. 46) and "iron peroxide and alumina" (p. 125) are examples. The author, too, should not have included Cumberland hæmatite among the ironstones, nor granite among the strata adjoining the Coal-measures.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

On the Absorption Spectrum of Benzene in the Ultra-violet Region.

IN the *Transactions of the Chemical Society* for August Messrs. Baly and Collie, referring to the previous work of Baly and Desch (*Trans. Chem. Soc.*, 1904, lxxxv., 1029, and 1905, lxxxvii., 766) on the absorption spectrum of acetylacetone and its derivatives and the conclusions arrived at, namely, that the absorption band is caused by dynamic isomerism, or rather isodynamic changes, are led to infer from the occurrence of bands in the spectrum of benzene that these also are caused by the making and breaking of the carbon bonds in the molecule of the substance. I have given a similar, but not identical, explanation of the cause of the bands in the spectra of uric acid, murexide, and the ureides, and have pointed out that there is but little difficulty in accepting a like explanation in order to account for the bands in aromatic hydrocarbons, seeing that this would harmonise with Kekulé's view of the constitution of benzene. The particulars are contained in two papers communicated to the Chemical Society on May 17, but as they are still unpublished I cannot refer to them in detail.

Messrs. Baly and Collie consider all the possible phases in change of linking between the six carbon atoms in benzene, and assign a band to each phase. In doing this they feel justified in assuming that an even number of carbon atoms is concerned in each individual process, and in accordance with chemical evidence it could scarcely be imagined otherwise. They argue that there are only seven different makings and breakings of bonds possible, to which seven different absorption bands should belong, and on investigating the spectrum of benzene they find only seven bands. Seven bands were photographed (*Phil. Trans.*, 1879), as they remark, by Hartley and Huntington, but no measurements are given. The wave-lengths of lines in the ultra-violet had not been determined at that time (1878), with the exception of the principal lines of cadmium measured by Mascart, hence the reason for the absence of measurements.

In a subsequent observation (Hartley and Dobbie, "Notes on the Absorption Spectrum of Benzene," *Trans. Chem. Soc.*, 1898, lxxiii., 695) seven bands were photographed and measured, but one of these appeared to differ from the others in constitution, and it was indicated as doubtful; it is also a feeble band. The general character possessed by the first six bands was most distinctly marked in the four strongest; each was stronger and generally sharper towards the side where the rays of shorter wave-lengths lie, and was weakened in the opposite direction, as if the bands were composed of groups of lines occurring closer together and being stronger towards the more refrangible edge. Baly and Collie appear to have overlooked some points of importance in this communication, since they state that Hartley and Dobbie found only six bands, and that the measurements of the actual heads of the bands are not given. They give a series of numbers derived from Hartley and Dobbie's measurements which for comparison with their own are printed in a parallel column. The gist of the paper by Hartley and Dobbie was to show the structure of the benzene absorption spectrum partly by measurements and partly by the aid of a photograph. The bands which distinctly showed the structure were numbered, but unfortunately the manner in which the photograph was reproduced failed to render delicate details which were visible on the original plate. The statements contained in the paper appear, however, to have been clearly and fully understood by W. Friederichs, who photographed the vapour of benzene with a Rowland grating. He found fifty-six bands of absorption in its spectrum in the ultra-violet, which are arranged in eight groups, and he compared the principal lines of each group with the

points of maximum absorption, or most persistent edges in each of the bands measured by Hartley and Dobbie. This is shown in the following statement quoted from his paper (Wilhelm Friederichs, *Zeit. für wissenschaftliche Photographie*, B. iii., 154–164, 1905).

I have added in italics the wave-length numbers corresponding to Baly and Collie's oscillation frequencies for comparison:—

	Vapour. Friederichs. λ	Solution in alcohol. Hartley and Dobbie. λ	Difference.	Baly and Collie. λ
(1)	2670	2681	11	*2683*
(2)	2633	—	—	*2656*
(3)	2588	2599	11	*2610*
(4)	2526	2541	15	*2554*
(5)	2458	2485	27	*2484*
(6)	2404	2429	25	*2433*
(7)	2356	2376	20	*2380*
(8)	2305	2330	25	—

He points out that the bands of the substance in solution which without doubt correspond with those of the vapour are all shifted towards the red, as might be expected, but that the shift appears to be greater the smaller the wave-lengths of the absorbed rays. The comparison of Baly and Collie's numbers with those of Hartley and Dobbie is very interesting in this connection, inasmuch as they show a close general agreement in their divergence from the measurements of Friederichs. Furthermore, the following points may be noted:—

First, the omission of the second band in Hartley and Dobbie's spectrum; second, the omission of the eighth band by Baly and Collie; third, there is a close agreement between Hartley and Dobbie's and Baly and Collie's numbers in the first, fifth, sixth, and seventh bands, but the two sets of measurements for the third and fourth bands differ more widely than the others.

It may be mentioned that the second very narrow band is visible on the photographs taken by Hartley and Dobbie, though it can scarcely be considered as measurable; no doubt a longer exposure would have rendered it more plainly. Those who have measured similar series of bands in the visible region, for example, those in the spectrum of potassium permanganate, which are also eight in number, will appreciate the close approximation of the above figures.

W. N. HARTLEY.

Royal College of Science, Dublin, September 19.

Rhymes on the Value of π.

THE following rhyme is in imitation of the French and German verses given in NATURE (August 17) in which the number of letters in each word correspond to a numeral in the value of π. The three concluding lines are somewhat obscure; it seems to have occurred to the author that the method is a misuse of language, and he expresses the hope that NATURE will take a more lenient view than Dr. Johnson might be imagined to express.

To the Editor of NATURE.

Sir,—I send a rhyme excelling
3 1 4 1 5 9
In sacred truth and rigid spelling.
2 6 5 3 5 8
Numerical sprites elucidate
9 7 9
For me the lexicon's dull weight.
3 2 3 8 4 6
If "Nature" gain,
2 6 4
Not you complain,
3 3 8
Tho' Dr. Johnson fulminate.
3 2 7 9

F.R.S.

The Celtic Pony.

IN a review, signed "R. L.," of "The Faröes and Iceland," in NATURE of September 21 (p. 506), I was surprised to read that I had credited Prof. Ewart "with being the first to regard Przewalsky's horse as a variety of *Equus caballus*." I have just re-read the paragraph relating to the wild horse in my "Appendix on the Celtic Pony," and I can find no passage which, it seems to me, could by any possibility be made to bear this strange construction.

Sanson's subspecies *E. c. hibernicus* appears to include all the various ponies of the British Isles, the Breton in France, as well as the horses of Iceland, Norway, and Sweden. It has been recognised for some time past that the Icelandic horses are of two different types, while the Swedish horses are admittedly very mixed. Moreover, as a result of a recent tour in Norway, it has become evident to me that there are in that country at least two distinct kinds of native horses (represented by the pure fjord horse and the Gudbrandsdal horse). In view of these considerations, the statement that the Celtic pony is "probably inseparable" from the somewhat heterogeneous assemblage (as it now appears to be) included under *E. c. hibernicus* becomes a little obscure. But, as "R. L." points out, I did *not* make this statement. I grant, however, that it might have been better had I made some allusion to this matter.

But why I should have been expected in an "Appendix on the Celtic Pony" to have entered into a discussion as to the proper technical name to apply to *E. przewalskyi* or to have recorded an irrelevant criticism of Prof. Ridgeway's new name of *E. c. libycus*, I am at a loss to understand.

FRANCIS H. A. MARSHALL.

The University, Edinburgh, September 24.

GREEK ARCHÆOLOGY.[1]

THE archæologist justly ranks himself as a contributor to the world's knowledge on the same level as those who discover previously unknown forces in nature or new facts in the life-history of animals, extinct or living. Archæology, which is a branch of the great science of anthropology, discovers and correlates new facts in the early history of civilisation. Greek archæological discovery must always be of most especial interest, since it tells us of the origins of that early civilisation of the Mediterranean basin from which our present-day culture is derived. One of the most welcome yearly publications dealing with the subject is the "Annual of the British School at Athens," the tenth volume of which lies before us. It deals with the British work of 1903–4, besides containing independent articles on matters of archæological interest.

Dr. Arthur Evans's work at Knossos does not occupy so much space in the "Annual" as usual. The discoveries of the year, while most interesting, were not so new and epoch-making as those of former years, and the chief find, the tombs of "Ja'far's Papoúra" (τοῦ Τζαφὲρ ἡ Παπούρα) and Isópata, are described by Dr. Evans in a separate communication to *Archaeologia*. The first-named tombs, on a hill north of the Knossian palace, were of various types; (1) chamber-tombs approached by a *dromos*; "in many cases these contained clay coffins, in which the dead had been deposited in cists, their knees drawn towards the chin"; (2) shaft-graves; (3) pit-caves, "or pits giving access to a walled cavity in the side below." In 2 and 3 the skeletons were extended at full length. On the hill of Isópata, about two miles north of Ja'far's Papoúra, a very fine tomb, no doubt that of a king, was found, with a smaller one by its side. The larger consisted of a square chamber of limestone blocks, eight metres by six, "with the

[1] "The Annual of the British School at Athens," No. x. Session 1903–4. (London: Macmillan and Co., Ltd.)

side walls arching in 'Cyclopean' fashion towards a high gable," which had long ago been quarried away. The lofty entrance-hall was approached by an imposing rock-cut dromos. "In the floor of the main chamber was a pit-grave covered with slabs. Its contents had been sifted for metal objects in antiquity, but a gold hairpin, parts of two silver vases, and a large bronze mirror remained to attest the former wealth of such. A large number of other relics were found scattered about, including repeated clay impressions of what may have been a royal seal. Specially remarkable among the stone vessels is a porphyry bowl of Minoan workmanship, but recalling in material and execution those of the Early Egyptian Dynasties. Many imported Egyptian *alabastra* were also found, showing the survival of Middle Empire forms besides others of Early Eighteenth Dynasty type. Beads of lapis lazuli also occurred, and pendants of the same material, closely imitating Egyptian models. Four large painted jars with three handles illustrate the fine 'architectonic' style of the Later Palace of Knossos, in connexion with which the great sepulchral monument must itself be brought."

The form of this square-chambered mausoleum is unique, and may be compared as a contrast with the *tholos* or beehive tombs of the Greek mainland. Dr. Evans says that he was tempted to recognise in it the traditional tomb of Idomeneus, but that the other tomb near by, which is cut in the rock, is hardly considerable enough to be taken for that of Meriones, which tradition placed beside the other. Nevertheless, Dr. Evans's identification may be correct; the important tomb on the slope of the hill looking towards Knossos and Heráklcion would naturally be identified by the later Greeks as the resting-place of one of the greatest heroes of the island, and any other tomb close by, whether it were as large as the first or not, would then be dubbed the grave of his legendary companion.

Another interesting discovery was made outside the limits of the palace in the shape of a Minoan paved way leading due west from the "Stepped Theatral Area" discovered in 1903 towards the modern road to Candia. By the side of this were found magazines with interesting deposits of inscribed tablets apparently referring to the contents of the ancient royal stables and armouries; chariots, wheels, and yokes are pictured on them, and large numbers of arrows. Close by were found bundles of the very arrows mentioned on the tablets. A later Roman causeway overlay part of this road, but this was evidently merely a coincidence, for that the knowledge of the old road was lost after the close of the Minoan period is shown by the fact that during the early Hellenic ("Geometrical") age a well was sunk over the old Minoan way and driven right through it. This is a very interesting proof of the entire break in culture between the Mycenæan and "Geometrical" peoples in Crete, and is a strong argument in the armoury of those who believe that the Minoans or Mycenæans were not Greeks in our sense of the word at all, but a totally different race probably of non-Indo-European speech.

In the palace itself interesting finds were made. A section cut in the western court enabled more accurate notes of the stratification of the ancient remains to be made, resulting in a further subdivision of the Minoan period and a more accurate placing of the polychrome ("Kamáres") pottery as belonging to the stratum "Middle Minoan II." The Kamáres pottery is known by Egyptian evidence to be contemporary with the twelfth dynasty. The palace as it stands is late Minoan, which corresponds with the Egyptian evidence, which dates the Keftians who brought vases of the grand Knossian style to Egypt as contemporary with the eighteenth dynasty. Beneath the Minoan strata was found a deep Neolithic stratum going down to the virgin rock. From the modern surface of the ground to the base of "Early Minoan I." (the sub-Neolithic period) measures 5 m. 33 cm. in depth; the Neolithic stratum is 6 m. 43 cm. The date B.C. of the eighteenth dynasty and the late Minoan palace is roughly 1500; that of the twelfth dynasty and Middle Minoan II. about 2200. "Middle Minoan II." is 2 m. 50 cm. below the surface; the virgin rock is 7 m. 75 cm. From this the great age of human settlement at Knossos will be seen at a glance. A peculiarity of the Knossian site is that the late Minoan remains are found almost immediately beneath the modern surface of the ground. This points to the place having been kept clear of later buildings, the tradition of its sanctity and heroic associations having always persisted.

Fig. 1.—Two polychrome vessels of the Middle Minoan Period. From the Palace at Knossos.

An earlier western façade of the central court was also discovered, and further cists belonging to the first period of the later palace, in the magazines. The discovery of fragments of reliefs in these cists (one of them, representing the head of a charging bull, was identified by one of the workmen as a portrait of the devil) led Dr. Evans to suppose the existence of upper halls, to which the reliefs had belonged, above the magazines. These halls seem undoubtedly to have existed, and a ramp led up to them from the "Stepped Theatral Area."

These are all very interesting results, and show how much there is still to be discovered at Knossos.

The excavations of the British School at Athens at Palaíkastro are described by Messrs. Dawkins and Currelly. The remains of a shrine of the Cretan snake-goddess (analogous to those at Knossos and Gourniá) were found, besides some interesting *larnax*-burials. Mr. Dawkins gives a careful analysis of the pottery found in the town ruins, and a very useful comparative table of the strata of the Minoan period, with illustrative examples from Cretan and non-Cretan sites (p. 195). Mr. H. R. Hall publishes a

photograph of an important Egyptian tomb-painting depicting Minoan ambassadors bringing rare vases of Cretan workmanship to the court of Queen Hatasu or Hatshepsu at Thebes.

In connection with the point raised anent the Minoan way, already described, at Knossos, that there was a great gap in history between the last (presumably non-Aryan) Minoans and the first (Aryan) Hellenes, we may note that Mr. R. S. Conway returns to the charge in defence of the "Aryanism" of the Minoans in another article on the Eteocretan inscriptions of classical times, which he considers to represent the speech of the Minoan Cretans. There is no proof of this whatever, and even if Mr. Conway were to succeed in proving the Indo-European character of this late "Eteocretan" language up to the hilt, this would not in the least shake our conviction that the old Minoans spoke a non-Indo-European tongue. The craniological and archæological evidence must be taken into consideration as well as the philological, which can apparently be twisted into meaning anything that the investigator wishes. The craniologist assigns the Minoans to the "Mediterranean" race, to which the ancient Egyptians also belonged; and the archæologist brings the Minoan and Egyptian cultures back almost to a common origin. Further, Mr. Conway's idea goes counter to those of many of the philologists themselves, especially Kretschmer, whose view that the præ-Hellenic speech of Greece was non-Aryan agrees with the results of craniological and archæological research, and is generally accepted now.

This completes the list of articles dealing directly or indirectly with the Minoan or Mycenæan antiquities, the relics of the prehistoric culture of Greece.

Mr. Dawkins contributes an interesting philological article, entitled "Notes from Karpathos," describing the linguistic phenomena of that little known island, which he visited two years ago. The dialect seems to be more divergent from that of Crete than might have been expected. It presents all the peculiar dialectical phenomena of the Southern Ægean. Such pronunciations as "hyaloshorzho" (χγαλοšορžο) for Καλοχωρίον, which strike one so forcibly in Crete, are well represented. Aberrant grammatical forms are not uncommon. The old third plural in -σι(ν) survives. Here we have a considerable difference from Cretan practice, which prefers third plural in -νε: "they went," in Cretan ἐφύγανε, is in Karpathian ἐφύγασι(ν), and "they are walking," Cretan πατούνε, is in Karpathian πατοῦσι(ν), which sounds quite "Attic." This is an interesting survival. Articles of this kind are of great use and value.

Mr. M. N. Tod and Mr. E. S. Forster add contributions to epigraphic scholarship, and the latter also describes Laconian topography and archæological sites. Mr. A. J. B. Wace has an article on Greek grotesque figures as charms against the evil eye. The modern Hellenes wear charms in the shape of little silver or coral figures of hunchbacks (*gobbi* or *gobbetti*) for the same purpose.

Dr. Schäfer's German article on "Altägyptische Pflüge, Joche," is apparently published in the "Annual" on account of the ancient Egyptian basket figured on p. 140, which is of the same type as the Greek *liknon*, discussed by Miss Jane Harrison in her note on the "Mystica Vannus Iacchi," which follows. Otherwise one would have thought that its proper place would have been found in an Egyptological publication. The Berlin Museum has a large collection of ancient Egyptian agricultural implements, which are, however, of course all, with the exception of a fine plough and the basket aforesaid, of well known types equally well represented in other museums.

H. R. HALL.

SOUTH AFRICAN MEETING OF THE BRITISH ASSOCIATION.

LETTERS from local correspondents in South Africa have just brought us some notes upon the recent meeting of the British Association. During the progress of the meeting several cablegrams which appeared in the *Times* were summarised in these columns, so that many of the matters mentioned by our correspondents have already been recorded. Dr. J. D. F. Gilchrist has sent us an account of the part of the proceedings of the association at Cape Town, and the following particulars in so far as they are connected with Cape Town are from his communication. As, following our usual custom, we have arranged with officers of the sections for reports of the proceedings at sectional meetings, it is unnecessary now to give any account of these meetings.

Dr. Gilchrist states that as early as August 6 some of the British Association visitors began to arrive in Cape Town by the *Tintagel Castle*; eighteen more arrived on August 8 by the *Kildonan Castle*, and forty-three by the *Durham Castle* on August 12. The main body, however (eighty-six), including most of the official party, arrived by the *Saxon* on Tuesday, August 15.

The voyage of the main party was favoured by excellent conditions of weather, and the usual routine of life and entertainments on board was diversified by lectures by members on appropriate subjects of interest, and in one or two cases by scientific work, such as the collecting of plankton and temperature observations of sea and air. A few advance copies of "Science in South Africa," a handbook prepared on the occasion of the visit, were on board, and afforded some insight into the scientific work and problems engaging the attention of South Africans.

On arrival at Cape Town Docks the passengers were transferred to the train waiting alongside, and about 10 a.m. on August 15 arrived at the main station, where they were met by the mayor, the hospitality committee, and others. The council of the association met at 12 noon and the general meeting at 2 p.m., and the formal business was quickly got through.

The details of the somewhat extensive programme were in an advanced state of preparation, the general plan and coordination of the whole having been undertaken by a central organising committee for South Africa, the local details by the several reception committees at the seven local centres to be visited. These local committees were subdivided into entertainment, hospitality, excursions, and finance subcommittees.

Great assistance was rendered by Mr. Silva White, assistant secretary of the British Association, who arrived some weeks before the first meeting and took over the general direction of, and responsibility for, the arrangements. He arranged for the services of four assistant secretaries, who were instructed as to the details to be carried out on certain sections of the programme allotted to them, an arrangement which was fully justified by the subsequent results.

The formal business of the association commenced with the presidential address, which was delivered on the evening of August 15 in the City Hall, which had just been completed in time for the meeting. The work of the various sections began the following day, and occupied the mornings from Wednesday, August 16, to Friday, August 18, half the sectional work being transacted at Cape Town and half at Johannesburg.

In the afternoon of August 16 there was a large attendance at the Governor's garden party, and in the evening the Mayor met the visitors at a reception in the City Hall.

A large number of papers were read on the mornings of the two following days. As a special feature of the papers and presidential addresses was their bearing on South African questions, exceptional interest was taken in the sectional proceedings.

The following excursions were made on August 17:—(1) botanical excursion to the Kloof Nek; (2) visit to Groote Schuur for lady members of the British Association by invitation of the Loyal Women's Guild of South Africa; (3) visit to the Central Electric Station of the Cape Town Corporation. In the evening a lecture was given in the City Hall before a crowded audience on "W. J. Burchell's Discoveries in South Africa," by Prof. E. B. Poulton, F.R.S.

The afternoon of August 18 was devoted to excursions; and a reception was held by Sir David and Lady Gill at the Royal Observatory. In the evening a lecture was given in the City Hall on "Some Surface Actions of Fluids" by Mr. C. V. Boys, F.R.S.

Saturday, August 19, was devoted entirely to the following excursions:—(1) geological excursion; (2) Wellington; (3) De Beers Explosive Works; (4) Houts Bay; (5) Groot Constantia and Tokai; (6) Robben Island; (7) Stellenbosch; (8) Admiralty Works at Simons Town and Marine Station at St. James; (9) Table Mountain *viâ* Saddle Face; (10) Table Mountain *viâ* Wynberg; (11) Table Mountain *viâ* Kasteel Poort.

Dr. W. Flint (librarian to the Houses of Parliament), who accompanied the association throughout its entire journey, has undertaken to send NATURE some account of the Natal, Johannesburg, and Rhodesian proceedings. The following notes are from a letter just received, with the promise of a further instalment by the next mail.

On the termination of the meeting in Cape Town the main body of the members of the association proceeded to Durban in the Union Castle steamers *Saxon* and *Durham Castle*. The former steamer left the docks on Friday evening, August 18, and its passengers were debarred from taking part in the numerous Cape Town excursions which had been arranged for the Saturday. The *Saxon* passengers had, however, the advantage of brief visits to Port Elizabeth and East London, at each of which ports of call a few hours were spent, and hospitality was tendered by the mayor and citizens. The *Durham Castle* proceeded direct to Durban, and, making a record passage, arrived a little in advance of the mail steamer. A party of some thirty persons elected to proceed to Durban overland in one of the trains provided by the Cape Government, which was proceeding to Durban to meet the steamers. A special geological excursion through the Hex River Pass on to the Karroo captured a few enthusiasts, who, under the guidance of Mr. A. W. Rogers, of the Cape Geological Survey, spent a few days which proved to be of great interest. These members necessarily had to deprive themselves of the pleasure of the Natal section of the tour. The trip overland to Durban, which occupied four nights and three days, was unanimously voted a great success, and as several of the passengers are proceeding to England by Beira and the east coast, the opportunity of seeing the Karroo was much appreciated.

The two days spent in Durban and the neighbourhood were very fully occupied, the hospitable ideas of the mayor and his numerous helpers having provided a very attractive programme. Tuesday morning, August 22, was occupied in settling down and taking the bearings of the town, and early in the afternoon a public welcome was tendered by the mayor, Mr. Henwood, to which Prof. Darwin responded. A garden party generously given by Sir Benjamin Greenacre, for which very elaborate preparations had been made, was partly spoiled by a heavy thunderstorm, but large numbers braved the downpour and were rewarded by seeing a few of the glories of the Berea.

Two lectures were given in Durban to very large audiences. Mr. Douglas W. Freshfield discoursed on "Mountains—the Highest Himalaya," and Prof. W. A. Herdman on "Marine Biology."

The second day in Durban was occupied chiefly with excursions. Perhaps the first place was taken by the entertainment provided by the Hon. Marshall Campbell at the Mount Edgecombe Sugar Estate. The contrast afforded by a Zulu war dance and a demonstration by Christian native girls was an object lesson which many were glad to have seen.

The excursion to Umkomaas was scarcely less enjoyed, the romantic subtropical scenery being a revelation to many of those who were privileged to be present. The botanists especially seemed to revel in the opportunity, the wealth of Strelitzias in their native habitat being particularly attractive.

On Thursday morning, August 24, the whole party left in four trains, to be known henceforth as A, B, C, and D trains, and arrived about mid-day in Maritzburg. The journey is one of the most attractive in South Africa, passing in its earlier stages through sugar, banana, and pine-apple plantations, and ascending rapidly to the Botha Hill heights, from which views of singular extensiveness and beauty are obtained. On reaching Maritzburg admirably complete arrangements were found to have been made, and members found themselves welcomed with great cordiality by Mr. A. W. Kershaw, the Mayor, and a host of willing citizens who had thrown themselves with great zeal into their task.

His Excellency Colonel Sir H. E. McCallum held a garden party at Government House which was a very successful function, and in the evening the Town Hall was thronged when His Excellency and the Mayor gave addresses of welcome. Colonel Bruce followed with a lecture on "Sleeping Sickness" which created great interest.

On the following day there were visits to the Government experimental farm and the Government laboratory, but it is to be feared that these were somewhat overshadowed by the Kafir dance and wedding which took place at Henley. The wedding was that of a young hereditary chief, and was preceded by the various dances and ceremonies customary on such an occasion. Never, probably, were so many photographs taken on a single day in Natal. The cameras were legion, and some of the photographers were not content with less than two or three dozen of pictures.

In the evening the young Natalian member of the official party, Mr. H. D. Ferrar, by special request, gave a lecture on "Antarctic Regions," he having been a member of the *Discovery* Antarctic Expedition.

Both in Durban and Maritzburg all members of the association had free use of the municipal trams, and nothing was left undone to ensure the comfort and enjoyment of the visitors, who in their turn were loud in their praises of the reception accorded.

TWO REPORTS OF THE FRENCH GLACIER COMMISSION.

A RECORD of observations on snowfall and avalanches undertaken by the Forestry Department of Savoy during 1904 on the south-west flank of Mont Blanc is contained in a paper entitled "Observations sur l'Enneigement et sur les Chutes d'Avalanches," issued by the Commission française des Glaciers (Paris: Club Alpin français). The

paper is a continuation by M. Mougin of his report of June, 1903, and deals with the results obtained from the seven instruments placed at appointed stations between the village of Houches and the Aiguille du Goûter. Unfortunately, the snow-gauge placed on the Aiguille du Goûter was destroyed by a party of young students from Geneva who attempted the ascent of Mont Blanc without guides in 1902. On the Tête-Rousse, again, the instrument was found completely empty; fortunately, however, the platform snow-recorder, placed on the glacier, enabled an estimate of the snowfall to be made.

The general results derived from the records of these seven stations show that between 1000 metres and 3200 metres the snowfall increases with altitude, but the results are not altogether satisfactory. Thus the record at 2100 metres gives a fall equivalent to 0.3194 mm. of water only, whereas the stations above and below show falls of 1.848 mm. and 0.491 mm. respectively.

Even if the upper station is excessive, the station above at 2850 metres at the Pierre-Rondestill shows an increase, being 0.4461 mm.; it is possible, therefore, that the mouth of the instrument has become blocked by a film of verglas. With regard to the large fall recorded at 2550 metres, it is possible that here we have the altitude at which the greatest precipitation takes place. The loss of the instrument at the summit of the Aiguille du Goûter is all the more to be regretted on this account, as it would undoubtedly have thrown light on this point, and it is to be hoped that the instrument may speedily be replaced.

The report gives a detailed description of the instruments used. These consisted of horizontal boards placed one metre above the ground, and also of Vallot's snow-gauges of a modified design.

Comparative experiments were made during the winter at Chambéry between the official rain-gauge, the Vallot tubes, and the snow-table. The results are expressed in tables and by curves. No useful comparisons could be made between the rain-gauge and the Vallot tubes, but the results obtained with the latter instrument are compared with those obtained with the snow-table, and are expressed both in depth of snow and amount of water melted. The small number of snowstorms during the winter of 1902–3 was also unfavourable to any definite conclusion being arrived at; further experiments are required.

The report ends with tables showing the snowfall and number of avalanches which fell in Savoy during 1902, also the damage done to forests, roads, and water-courses, and accidents to men and animals.

Another report received from the Commission française des Glaciers deals with the observations by M. Paul Girardin on the glaciers of Maurienne, Vanoise, and Tarentaise during August and September, 1903, and also with the glaciers of the massif of La Vanois in 1903, by J. A. Favre (Extrait de l'Annuaire du Club Alpin français, vol. xxx., 1903). M. Girardin arrives at the conclusion that these glaciers are retreating, the amount varying in different glaciers and even in different lobes of the same glacier. The general law is, therefore, complicated by local shade, &c. Retreat is most marked where surface moraines are absent, while those covered thickly with débris are more stationary. The rate of retreat has, however, diminished during the last ten years.

In the massif of the Vanoise we find the same story. Glaciers like the Grands-Couloirs, Pelvoz, &c., are all losing in thickness. In the case of the Pelvoz a new medial moraine has appeared owing to the marked ablation, while a glacier marked on the map north of the Col d'Aussois has completely disappeared.

E. J. G.

INTERNATIONAL METEOROLOGICAL CONFERENCE AT INNSBRUCK.

Second and Third Meetings.[1]

AMONG the various points brought under notice, the president, Dr. Pernter, stated that M. Violle wished that his proposals made to the meeting at Southport on the question of solar radiation should be discussed. After considerable deliberation, it was resolved that the principal observatories should be requested to make observations of solar and terrestrial radiation. Measurements should be made daily, those of solar radiation at 11h. a.m. or from 11h. a.m. to 1h. p.m., and those of terrestrial radiation at 10h. p.m. or from 10h. p.m. to 12h. p.m. The apparatus used should be exclusively Angström's compensation actinometer.

Upon the subject of excessive rainfall, Dr. Landa, of the k.k. hydrographisches Central-Bureau (Vienna), proposed (1) that meteorological offices should be invited to inquire into the causes of origin of cases of excessively heavy rainfall over large areas, including those which have already occurred, and any that may occur in future, in the districts under their supervision, and to publish the results of their investigations, and (2) that it should be recognised as useful to investigate the historical documents of various countries for particulars of abnormal meteorological occurrences, such as floods, droughts, very severe winters, &c., and to classify and publish the results of their researches.

The classification of meteorological stations, according to the nature of the work carried out, was referred to the International Meteorological Committee, as was also the definition of such phenomena as hoar-frost, silver-thaw, glazed frost, &c.

On the important question of long series of homogeneous observations, necessary for the study of secular variations, the conference adopted Dr. Hellmann's proposal that central meteorological offices should establish in their respective organisations one or more secular stations, according to the extent of the country, and should carry on the observations as uniformly and continuously as possible. At the same time, the conference expressed the hope that old series of observations might be critically discussed and published.

On the proposal of M. Rosenthal, the conference requested General Rykatcheff to undertake, on the part of the Central Physical Observatory, St. Petersburg, the publication of a summary of the results of observations made during the last century. Dr. Hellmann was requested to assist in the preparation of this useful work.

Prof. von Bezold raised the question of the status of the conferences of directors, and of the International Meteorological Committee; he thought they should maintain an official character, so far as possible, and that the number of meetings should be as few as practicable. After considerable discussion, a proposal by Dr. Hellmann was adopted, viz. that the conference should request the International Meteorological Committee to draw up a standing order relating to the International Meteorological Organisation, at the same time taking note of the historical development of the committee. This rule, dealing with conferences of directors, the international committee, and the subcommittees, should be submitted to the next conference of directors for discussion.

M. Froc made a communication respecting the organisation of the meteorological service of the

[1] An account of the opening meeting appeared in NATURE of Septem 21 (p. 510).

Chinese Maritime Customs. We have not yet received the protocol of the last meeting, but we may state that it included reports of the various commissions.

With regard to the Solar Commission appointed in 1903, complete arrangements were made for bringing together all data necessary for the study of simultaneous solar and terrestrial changes. Letters had been received from Prof. Hale and M. Deslandres placing their photospectroscopic results at the disposal of the commission.

INTERNATIONAL UNION FOR COOPERATION IN SOLAR RESEARCH.

AT last the importance of solar research is asserting itself, even in the minds of some who in the past have shown it scant favour. It is not a little remarkable that during last month two international bodies held meetings, both of them concerned with solar observations, the one, the Solar Commission, established in 1903, which met at Innsbruck, dealing with them in relation to the meteorological changes on the earth, the other, the Solar Union, established in 1904, which met at Oxford, dealing with the physics of the sun itself. There is thus fortunately a sharp-cut line between these two efforts to advance our knowledge, and we hope that both bodies will ultimately find out the best ways of doing this. In a preliminary circular we read:—

The number of international organisations having considerably increased lately, it is desirable that overlapping of the work of different organisations should be avoided as much as possible. As far as solar research is concerned, a committee on questions dealing with radiation and the connection of solar and terrestrial phenomena has been appointed by the International Meteorological Committee. It will probably be found advisable to omit for the present the investigation of the relation of the sun-spot cycle to meteorological phenomena from the programme of the union; but the question of the solar constant being of fundamental importance must form from the beginning an essential portion of its work. The astronomical and meteorological aspects of solar radiation are, however, very different, and there is no reason to doubt that some arrangement can be made by which the efforts of the Meteorological Committee and those of the Union on Solar Research may be united.

We have not yet received the official protocols of the Oxford meeting, but some points may be referred to. The meeting was well attended, the following foreign men of science being present:—Prof. K. Ångström, Acad. Sci. (Stockholm); Prof. A. Belopolski, Acad. Sci. (St. Petersburg); Fr. Cirera, Ast. Soc. of France; Cte. de la Baume Pluvinel, Ast. Soc. of France; Mr. H. Deslandres, Ast. Soc. of France; Prof. W. S. Eichelberger; Mr. Fabry, Physical Soc. of France; Mr. G. E. Hale, Nat. Acad. Sci. (Washington); Mr. Hansky, Acad. Sci. (St. Petersburg); Mr. J. Janssen, Acad. Sci. (France); Prof. W. H. Julius, Acad. Sci. (Amsterdam); Prof. H. Kayser, German Physical Soc.; Mr. Perot, Physical Soc. of France; Prof. E. Weiss, Internat. Assoc. Acad.; Prof. Wolfer.

Dr. Janssen was elected honorary president, and Sir Wm. Christie president, of the meeting.

Among the many resolutions passed were the following, laying down the principles which should be followed in the proposed cooperation:—

(1) Cooperation is desirable in the various branches of solar research such as visual and photographic observations of the solar surface, visual observations of prominences and observations of the solar atmosphere with spectroheliographs of various types.

(2) When an institution has collected and coordinated results from various sources, members of the union shall be requested to place their observations at the disposal of the said institution.

(3) In the case of investigations which have not yet been thus collected and coordinated, special committees specially nominated by the union shall be charged with the work of preparing and carrying out the needful cooperation.

(4) It is proposed forthwith to organise such cooperation in two branches of research:—

(*a*) The study of the spectra of sun-spots.

(*b*) The study of the records, by means of the H and K light, of the phenomena of the solar atmosphere.

(5) The committee lays special stress on the fact that, notwithstanding the obvious utility of cooperation in certain cases, individual initiative is the chief factor in a very large number. It is as much the duty of the union to encourage original researches as to promote cooperation.

Much time was spent in discussing the constitution of the union, and several committees were appointed. There were most interesting discussions on solar radiation, Prof. Angström describing his instrument which has now been taken as the standard, and we may add that as this subject is also dealt with by the International Meteorological Committee, Prof. Ångström has been appointed chairman of the committees appointed by both organisations. The executive is to consist of a committee with Prof. Schuster as chairman, and a "computing bureau" is suggested at Oxford in charge of Prof. Turner, which is to deal, if necessary, with classes of observations not already provided for.

The next meeting is to be held at Meudon in two years' time.

NOTES.

WE notice with much regret that Sir William Wharton, K.C.B., F.R.S., died at Cape Town on September 29 from enteric fever and pneumonia, at sixty-two years of age.

WE regret to see, in the *Athenaeum*, the announcement of the death, in his sixty-ninth year, of Dr. W. von Bezold, professor of physics and meteorology at the University of Berlin, and director of the German Meteorological Institute.

THE death is announced of Dr. A. H. Japp, author of a life of Thoreau, several works on natural history, and "Darwin and Darwinism."

THE International Congress on Tuberculosis was opened at Paris on Monday, October 2, by the President of the French Republic. Dr. Hérard, the president of the congress, gave an address on international medical congresses, and the services which they have rendered in the struggle against consumption. Addresses were then given by the foreign delegates, and by M. Loubet.

A REUTER message from Gothenburg reports that a severe shock of earthquake was felt on September 26, 1.30 p.m., at Lundby, in the island of Hisingen. Subterranean rumblings were heard, and the houses suddenly began to rock so violently that inner and outer walls were cracked. The disturbance lasted about a minute.

NEWS has been received from Samoa that a volcanic eruption occurred on the Samoan islands on the morning of August 21. The eruption was preceded by a violent earthquake shock, which destroyed a large number of buildings. During the eruption large masses of material were ejected, and for five days lava flowed over more than four miles of the surrounding country.

IT is officially reported that a case of cholera occurred in Berlin on September 23, the victim being a canal bargeman on one of the Berlin canal harbours.

THE provisional programme for the session 1905–6 has now been published by the Royal Geographical Society. The first meeting will be held on November 6, when an introductory address will be given by the president, Sir George T. Goldie, K.C.M.G., F.R.S. The paper for the evening will be "Travels in the Mountains of Central Japan," by the Rev. Walter Weston. On November 20 the paper will be "First Exploration of the Hoh-Lumba and Lobson Glaciers (Himalaya)," by Mrs. Fanny Bullock Workman; on December 4, "Exploration in the Abai Basin, Abyssinia," by Mr. H. Weld Blundell; and on December 18, "Exploration in New Guinea," by Mr. C. G. Seligman. Other provisional arrangements include the following papers:—Colonel Sir T. H. Holdich, K.C.M.G., will deal with "Unexplored India"; Prof. J. W. Gregory, F.R.S., takes up "The Economic Geography of Australia"; Baron Erland Nordenskjöld will lecture on "Explorations in Bolivia and Peru"; and Prof. Alleyne Ireland on "The Philippine Islands." Mr. G. F. Scott Elliot will read a paper on "The Geographical Influences of Water Plants in Chile," and Mr. Laurence Gomme on "Maps of London." In the research department, Sir Clements R. Markham, K.C.B., F.R.S., will lecture on the subject "On the Next Great Arctic Discovery: the Beaufort Sea." In this lecture Sir Clements Markham will advocate detailed investigation of the unknown region lying between Prince Patrick Island and the New Siberian Islands.

THE Bureau of the Government Laboratories of the Interior has issued a Bulletin (No. 25) containing two articles by Mr. R. C. McGregor on birds from various islands of the Philippine group. Several species are described as new, among the most interesting of which is perhaps a new owl of the genus Otus. Illustrations are given of the enormous nesting-mounds of the Philippine megapode and of the nests and eggs of three remarkable species of swifts from the archipelago.

THE contents of the *Zoologist* for September include an illustrated article by Mr. R. B. Lodge on birds nesting in Andalusia (in the course of which allusion is made to the devastation among the bird-fauna caused by the late drought), and the second instalment of the editor's essay on extermination. Much interesting information will be found in the latter with regard to the destruction of animals caused in different parts of the world by floods, drought, pestilence, &c.

BIRDS obtained from the islands lying between Kiushu and Formosa form the subject of an illustrated paper communicated by Mr. M. Ogawa to vol. v., part iv., of *Annotationes Zoologicae Japonenses*. Coloured plates are given of a Garrulus, a woodpecker, and a heron of the genus Nannocnus, described as new. Special interest attaches to the description, by Mr. H. Sauter, of a riband-like fish from the Sagami Sea regarded as indicating a new genus and species (*Ijimaia dofleini*) of the small and peculiar family which the author considers to be typified by the Japanese and Indian Ateleopus, the new genus being characterised by the subterminal mouth and short ventral fins.

THE mutual affinities of the species of cray-fishes of the genus Cambarus forms the title of the only biological paper in No. 180 of the *Proceedings of the American Philosophical Society*. The author, Dr. A. E. Ortmann, finds that the commonly accepted division of the genus into five groups is not based on natural affinities, which has led to some erroneous conclusions with regard to geographical distribution. Observations on columbium and tantalum, by Mr. E. F. Smith, and an inquiry into the pressure and rainfall conditions of the trades monsoon area, by Mr. W. L. Dallas, are the titles of other articles.

THE entomological collection of the natural history branch of the British Museum will shortly be augmented by the collection of beetles bequeathed by the late Mr. Alexander Fry, which has been already deposited in the building. It is reported to be the finest collection of its kind in the country, and although not especially rich in types, contains an unrivalled series of weevils and longicorns. The total number of species in the collection is reported to be about 72,000, represented by some 200,000 specimens, many of these species being new to the museum. The cabinet includes the collections made by the late Mr. John Whitehead in Borneo and by Mr. W. Doherty in the Malay Archipelago generally. The bequest also includes a number of valuable entomological books. It may be mentioned that the collection of domesticated animals in the north hall of the museum has been recently enriched by the gift of statuettes of two famous racehorses, namely, "Persimmon," the property of His Majesty the King, and his son "Zinfandel," owned by Lord Howard de Walden; H.R.H. the Prince of Wales being the donor of the one and Lord Howard de Walden of the other.

THE fourth part of the thirty-third and the first part of the thirty-fourth volume of Gegenbaur's *Morphologisches Jahrbuch* contain an exceedingly interesting and important article on the papillary ridges and grooves on

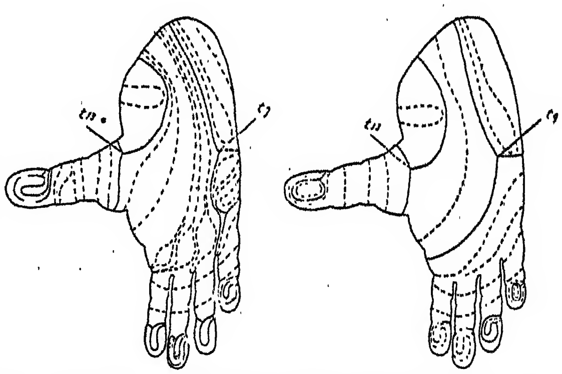


FIG. 1.—Two examples of the plantar surface of the right hind-foot of the chimpanzee to exhibit, in a diagrammatic manner, the "triradius" (*tr*). After Schlaginhaufen.

the sole of the foot in the Primates (inclusive of man), with especial reference to their serial correspondence with those of the palm of the hand, which have already been fully worked out by Hepburn and others. The article, which is by Dr. O. Schlaginhaufen, is far too long to permit of even a *précis* of its contents being given in this place, but it may be mentioned that the general arrangement of the papillary tuberosities is the same on the sole as on the palm. The most generally interesting fact brought out by the author's investigations is that while in all the Old World Primates (inclusive of man) the ridges and grooves on the sole in the neighbourhood of the great toe, or pollex, are so arranged as to form a triradiate system, termed the triradius, this feature is totally wanting in the monkeys of the New World. We have thus a new and deep-seated distinction between "Catarhini" and "Platyrhini."

AMONG the contents of the latest parts of the *Morphologisches Jahrbuch* (vol. xxxiii., part iv., and vol. xxxiv., part i.) may be mentioned an article by Mr. E. Göppert on the brachial artery of the Australian spiny anteater (Echidna), with special reference to the arterial system in the fore-limb of mammals in general, and a second, by Dr. O. Grosser, on the existence of a distinct segmental arrangement in the superficial vascular system of the human chest. In the second of the two volumes Dr. E. Küster describes the so-called *tastfeder* (sensory feathers) found at the base of the beak in owls and other birds, which are shown to be provided with sensory corpuscles, and are correlated by the author with the "feelers" or vibrissæ of mammals.

ALL the articles in the two concluding parts (iii. and iv.) of vol. lxxix. of the *Zeitschrift für wissenschaftliche Zoologie* deal with the anatomy and development of invertebrates. The minute structure of the eye receives the attention of two writers, Mr. H. Merton discussing the retina in nautilus and other dibranchiate cephalopods, while Mr. M. Nowikoff describes the eye and frontal organs of the branchiopod crustaceans. The spermatozoa of the common intestinal round-worm (Ascaris) receive attention at the hands of Mr. L. Scheben, of Marburg, Mr. K. Thon treats of the excretory organs of the hydrachnid family Limnocharidæ, while Mr. Stoffenbrink records the effects of special nutrition on the histological constituents of the fresh-water planarians. Finally, Mr. A. Zwack discusses the minute structure and mode of formation of the "ephippium" of the fresh-water flea (Daphnia), while Dr. E. Martini devotes himself to observations on the amœba-like Arcella.

THE latest number of *l'Anthropologie* (vol. xvi., No. 3) contains a useful article on Paumotu fishing implements. The British Museum is singularly poor in specimens from these islands, and the "Album" of Edge-Partington and Heape only figures two or three fish-hooks. In the present article a dozen hooks are figured and described; the construction of the canoes and method of sewing the planks are also illustrated. An article on the musical instruments in French Congo is diminished in value by errors in the illustrations; the *bambour* on p. 289 is reproduced from a sketch, and the artist has omitted the pins to which the strings are attached, making it appear that there is no means of altering the tension of the cords.

THE Department of Agriculture in Jamaica has been at considerable trouble to effect the improvement of home-grown tobacco, and if the experiments carried out at Hope Gardens may be taken as a criterion, there is a promising future for Sumatra wrapper-tobacco grown in the open and for Havana leaf, both shade-grown for wrapper and outside-grown for filling.

THE South Orkney Islands, lying about 600 miles south-east of Cape Horn, were visited by members of the Scottish National Antarctic Expedition voyaging in the ship *Scotia* in February, 1903. The collections of mosses and lichens obtained by Mr. R. N. R. Brown, the botanist of the expedition, are described in vol. xxiii., part i., of the *Transactions and Proceedings of the Botanical Society of Edinburgh*. Mr. C. H. Wright has identified six mosses which are all Antarctic, except one previously known only from Tristan da Cunha. Dr. O. V. Darbishire has worked out the lichens and distinguishes twelve species, including one, *Placodium fruticulosum*, new to science.

THE explanation that plants have developed thorns to keep off the depredations of herbivorous animals does not lend itself to experimental investigation, as the development would be an exceedingly slow process. But the argument that thorns are merely xerophytic structures is more easily put to the test, and Dr. L. Cockayne describes in the *New Phytologist* (April) his experiments with the New Zealand shrub *Discaria Toumatou*, known popularly as Wild Irishman, which in ordinary circumstances is abundantly furnished with long pungent spines. The experiments consisted in removing plants, at the stage when spines were beginning to be formed, to a moist chamber, where they were grown, and there maintained the leafy spineless habit characteristic of seedlings.

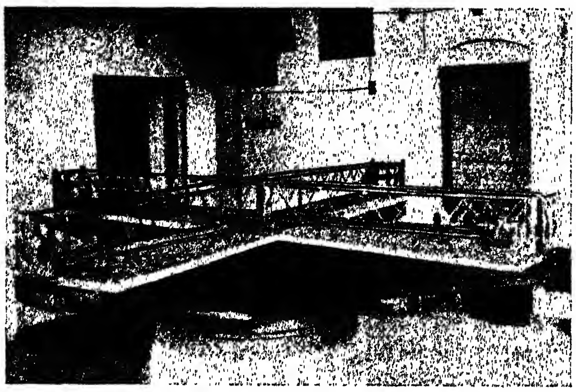
THE investigations of Prof. G. Haberlandt on the sense-organs of plants, which are of great scientific interest, form a suitable subject for popular exposition, and an account by Mr. G. C. Nuttall appears in the *Monthly Review* (September). The main result of Prof. Haberlandt's work was to show that where plants are sensitive to touch, at these points special adaptations of hairs or cells are found. The sensitiveness of tendrils and of the specialised leaves of Drosera and Dionæa is a matter of common knowledge, but the irritability of the stamens of such plants as Opuntia, the prickly pear, and Abutilon is less generally known. At certain spots the stamens of these plants are provided with papillæ which enable them to perceive contact stimuli. The concluding argument which is presented to the reader that plants are capable of experiencing sensations is by no means convincing.

THE German Meteorological Institute, of which the late Prof. v. Bezold was director, has published a second edition of its very useful "Instructions for Taking and Reducing Meteorological Observations." A great part of the work (as the title indicates) has been re-written and re-arranged to bring it up to date as regards the improvements in methods and instruments that have taken place in recent years. The work is divided into two volumes, dealing (1) with the requirements of stations of the second and third orders, and (2) with special observations and instruments; the latter part contains valuable explanations of the principles and adjustments of Richard's much used self-recording apparatus, of anemometers, sunshine recorders, and the nephoscope, all of which it is most essential that observers should thoroughly understand, but which are not always to be found in existing instructions. The aim of the work is to instruct observers in all parts of the operations required of them, from the choice of a suitable locality for a station, the erection of the instruments, and the method of taking observations, to the deduction of mean results, the most essential portions being printed in larger type. The work will certainly fulfil the intention of its author, viz. to render lighter the labours of observers and to ensure accuracy in their observations and calculations.

IN the *Memorie* of the Royal Institute of Lombardy (vol. xx.) Dr. Alessandri gives an account of the Regina Margherita Observatory at the summit of Monte Rosa, on the peak known as the "Signalkuppe," 4559 metres above sea-level. The station is under the control of the Central Meteorological Office at Rome, and it is intended (if possible) that observations should be made each year between July 15 and September 15. The difficulties encountered in the first year (1904) were so great that Dr. Alessandri states that the expedition can only be considered as a preliminary attempt, with the view of overcoming them in future years. The conveyance of instruments and materials from Alagna had partly to be done by mules and partly by men, at a cost of 62 centesimi for each kilogram

(2.2 pounds' weight), with the result that many of the instruments were broken in transit. Owing to the intense cold, the clogging of the apparatus by hoar-frost and violent snowstorms, together with the intense electrification of the atmosphere, rendered regular observations almost impossible with the means then available. The shade air-temperature at the summit of Monte Rosa is practically always below freezing point; the thermometers taken by Dr. Alessandri read to $-20°$ C., but the extreme temperature often fell below that. The mean reading of the barometer during the summer of 1904 was 17·1 inches; water therefore boiled at about 85° C. The lightning conductors frequently appeared like steadily burning candles, and the observers experienced at times such unpleasant shocks that it became advisable to retire within the observatory.

ABOUT twenty years ago Messrs. Michelson and Morley concluded from the results of their well known experiments that the ether in the neighbourhood of the earth is not at rest in space, but is carried along with the earth in its motion. Prof. Fitzgerald and Prof. Lorentz subsequently suggested that the experimental results of Michelson and Morley might also be explained by the dimensions of the apparatus being modified by its motion through the ether. In order to test this assumption, Messrs. E. W. Morley and D. C. Miller (*Proceedings Amer. Acad. Arts and Sciences*, xli., No. 12) have repeated on a more elaborate



scale the experiments of 1887, using two modified forms of apparatus. The sandstone of the earlier experiments was replaced in one form of apparatus by a structure of white pine, whilst in the final and more complete experiments a steel framework was used to support a system of pine rods. The figure shows the steel cross-framework adopted, with the trusses supporting the distance pieces and the mirror frames and telescopes in position. The entire apparatus weighed 1900 lb., and floated in mercury. As a result of the experiments, a nearly similar conclusion to that previously formed is arrived at. If the dimensions of the pine are changed, the change is of the same amount as with sandstone; if the ether near the apparatus did not move with it, the difference in velocity is apparently less than 3·5 kilometres per second.

THE *Journal of the Royal Sanitary Institute* for September (xxvi., No. 8) contains an important paper by Prof. Woodhead on the water supply problem in rural districts, together with the discussion thereon.

IN the *Century Illustrated Monthly Magazine* for October Prof. Chittenden gives a popular account of his researches on the amount of nitrogenous food required to maintain physiological equilibrium, which, should his results stand the test of time, will mean great economy in the future. General Horace Porter writes a graphic account of the investigations which led to the search for the body of Paul Jones and its ultimate recovery in the forgotten cemetery of Saint Louis, its identification, and removal to the United States.

WE have received the results of meteorological observations for 1900–2, and of rain, river, and evaporation observations for 1901–2, made in New South Wales. The latter work contains valuable statistics of rainfall for each month for the years in question, and various returns for other periods, *e.g.* the mean annual rainfall at all stations with three and up to fourteen years' records from 1889 to 1902 inclusive, and records for the whole of Australia for individual years since 1840. In the years 1901–2 severe and almost unprecedented droughts were experienced. The average fall for the whole colony for thirty-two years (1871–1902) is 24.15 inches, but in 1901 the amount was only 18.15 inches, and in 1902 14·09 inches, the lowest average on record with the exception of that for the year 1888, when it was only 13·40 inches. The effect on sheep grazing was disastrous; the number of sheep in the western division during seven years ending with 1901 dwindled from about 16 millions to 5 millions, representing a loss to the State of about 30 millions sterling.

IN the current issue of the *Journal of the Franklin Institute* the first instalment is published of an elaborate monograph on mica by Mr. G. W. Colles. The subject is dealt with chiefly from an industrial point of view, the present, past, and probable future of mica mining being discussed.

A SECOND edition of the second volume—dealing with the chemistry of manufacturing processes—of "Chemistry for Engineers and Manufacturers," by Messrs. Bertram Blount and A. G. Bloxam, has been published by Messrs. Charles Griffin and Co., Ltd.

MR. OSCAR GUTTMANN, 12 Mark Lane, London, E.C., intends to publish a facsimile reproduction of all ancient pictures and engravings dispersed in libraries all over the world referring to the invention, early manufacture and examination, and first use of gunpowder. It is to be a work of art, printed by hand on the finest hand-made paper, with an imitation fifteenth century binding, and limited to about three hundred numbered copies.

WE have received from Messrs. J. J. Griffin and Sons, Ltd., 20–26 Sardinia Street, Lincoln's Inn Fields, W.C., their "T" list of thermometers and pyrometers for measuring temperatures between $-200°$ C. and 4000° C. The list is a fairly complete one, and comprises ordinary, technical, and standard thermometers, as well as the principal forms of electrical resistance, thermoelectric, and optical pyrometers.

MESSRS. PHILIP HARRIS AND CO., LTD., of Birmingham, have issued their diary intended for the use of teachers and others during the session 1905-6. A very complete calendar of the examinations to be held by the chief public examining bodies during the coming educational year is provided, and there are spaces for daily notes, general memoranda, addresses, and cash accounts.

WE have received from Messrs. Williams and Norgate a copy of a new work published by Herr H. A. Ludwig Degener, of Leipzig, entitled "Wer ist's?" The volume is similar in its scope to "Who's Who," and is edited by Herr H. A. L. Degener. In addition to the particulars given of distinguished Germans, the book also includes

biographies of famous living Austrians, Frenchmen, Englishmen, and celebrities of other nationalities. The Englishmen noticed in the volume appear to be politicians as a rule, and, so far as we have tested the book, the men of science and of letters selected for inclusion are neither numerous nor particularly representative.

WE have received from Messrs. W. M. J. Brooks and Co., Letchworth, Herts, a set of five templates, or curves, accurately cut in celluloid, representing respectively the parabola, ellipse, hyperbola, cycloid, and cubical parabola. When such curves are required it seems better that a student should make them for himself, but failing this Mr. Brooks's curves may prove useful in special cases. The price is 1s. each curve.

OUR ASTRONOMICAL COLUMN.

FURTHER RESULTS OBTAINED BY THE FRENCH ECLIPSE EXPEDITIONS.—In No. 12 (September 18) of the *Comptes rendus* MM. Deslandres and Andoyer give brief summaries of the results obtained by them on their respective expeditions to observe the recent total solar eclipse.

M. Deslandres directed the Bureau des Longitudes mission to Burgos, where the actual duration of visible "totality" was curtailed by clouds to one minute, which did not include either the second or the third contacts. The proposed photographing of the chromosphere spectrum was therefore impossible. Photometric observations of the corona were obtained, and M. d'Azambuja was able to measure the coronal radiation, obtaining figures which were decidedly lower than those obtained by M. Charbonneau in 1900. M. Kannapell obtained four photographs of the corona polarised by reflection. M. Blum obtained two photographs of the corona through coloured screens so arranged as to transmit only the gaseous radiation of the prominences. By comparing these with the ordinary photographs it will, probably, be possible to determine whether or not the prominences emit a more intense continuous spectrum than that emitted by the surrounding regions.

At El-Arrouch, 32 km. from Philippeville, M. Andoyer simply attempted to obtain as many direct photographs of the phenomena as possible. His instrumental equipment consisted of a photographic objective of 14 cm. (5·6-inch) aperture and 60 cm. (24-inch) focal length, mounted with two enlarging cameras which increased the diameter of the image by three and eight times respectively.

Altogether forty-four plates were exposed, eleven of them during totality. A negative exposed two minutes before totality shows a reversed image, due to over-exposure, and a silhouette of the corona.

ELEMENTS OF COMET 1886 VIII.—From eighty-six observations of comet 1886 viii., made by various observers between January 24 and May 20, 1887, Herr E. Fagerholm, of Upsala, has calculated a set of elements for the orbit of that object. These, as given below, appear in No. 4047 of the *Astronomische Nachrichten*, together with the details of the computation and of the planetary perturbations taken into account:—

$$T = 1886 \text{ Nov. } 28{\cdot}44284 \pm 0{\cdot}00267 \text{ (M.T. Berlin).}$$

$$\left.\begin{aligned} \omega &= 31^\circ\ 55'\ 34''{\cdot}53 \pm 18''{\cdot}25 \\ \Omega &= 258^\circ\ 13'\ 1''{\cdot}35 \pm 4''{\cdot}43 \\ i &= 85^\circ\ 35'\ 17''{\cdot}33 \pm 3''{\cdot}84 \end{aligned}\right\} 1887{\cdot}0$$

$$\log q = 0{\cdot}1704712 \pm 0{\cdot}0000214$$

THE FIGURE OF THE SUN.—In No. 2, vol. xxii., of the *Astrophysical Journal*, Mr. C. Lane Poor publishes the results of an investigation, carried out by him at the Columbia University Observatory, which seem to indicate a periodical variation in the figure of the sun agreeing in phase with the sun-spot curve. On measuring the equatorial and the polar diameters of the solar images on twenty-one plates taken by Mr. Rutherfurd in 1870, 1871, and 1872, he found indications that during this period the equatorial diameter was first increasing and then decreasing with regard to the polar diameter. To check this result he re-investigated the measures made by the German observers whilst adjusting, and determining the constants of, their heliometers for the transits of Venus in 1874 and 1882. The 1873–5 results showed a progressive change similar to that indicated by the measures of the Rutherfurd photographs taken in 1871–2, whilst the 1880–3 heliometer measures confirmed the photographic results of 1870–1. Yet another confirmation was found on measuring five solar negatives taken at Northfield (Minn., U.S.A.) during the years 1893–4, the change in figure being the same as in 1871–2 and 1873–5.

Plotting the differences between the polar and equatorial diameters in conjunction with the sun-spot curve, it is seen that the two agree, not only in point of time, but also of intensity, the excess of the equatorial diameter occurring at sun-spot maximum.

From these results it appears that the sun is usually an oblate spheroid, but at times of sun-spot minima the length of the polar axis increases in regard to that of the equatorial diameter, and the solar figure becomes prolate.

Mr. Lane Poor incidentally suggests that this variation of the solar figure may explain the anomalies in the motions of Mercury, Venus, and Mars.

BIBLIOGRAPHY OF HALLEY.—No. 14 of the Bulletin of Bibliography Pamphlets, issued by The Boston Book Company, contains the material for a bibliography of Dr. Edmond Halley, the second Astronomer Royal, and will be found a useful adjunct to any astronomical library. Reading through the numerous items, one is struck anew by the range and number of Halley's writings. The pamphlet is an extract from No. 4 (July), vol. iv., of the Bulletin of Bibliography published by The Boston Book Company, and costs 25 cents.

OBSERVATIONS OF JUPITER'S SATELLITES.—In No. 4045 of the *Astronomische Nachrichten* Profs. A. A. Nijland and J. van d. Bilt publish the results obtained from a large number of observations of Jupiter's satellites.

These observations were made with the 26 cm. Utrecht refractor during the period June 30, 1904–February 17, 1905, and in the tabulated results the time of the eclipse, transit or occultation of the particular moon is given, together with the difference between these and the calculated times.

A LOST DOUBLE STAR.—A remarkable chapter of coincidences is recorded in No. 7, vol. xiii., of *Popular Astronomy* by Prof. Doolittle, of the Flower Observatory, U.S.A. In Sir John Herschel's first catalogue of double stars, No. 165 was described as a 3″ pair with a position angle of 330°, its position being given as R.A. = 10h. 26·8m., dec. = +12° 32′ (1825). In 1878 Prof. Burnham directed his attention to the pair, and recorded its position angle as 205°·3, and its distance as 2″·59. Again in 1901 he observed the double with the 40-inch refractor, and obtained a measure agreeing with Herschel's record; but in 1902 he could find no trace of the pair observed in the previous year, nor of the star measured by him in 1878. Observations made this year with the 18-inch refractor of the Flower Observatory failed to reveal the double given by Herschel, but showed a very wide faint pair in the exact position given by him.

Thinking that Prof. Burnham in 1901 might have confused the sign of the declination, Prof. Doolittle turned his telescope to the same R.A. in declination *minus* 12°, and there apparently found exactly the pair that was wanted. This seemed to have cleared up the mystery; Prof. Burnham had in 1901 observed the wrong star.

A letter from that observer showed, however, that this is not the correct explanation.

The truth is that Herschel made a mistake of exactly one hour in recording the right ascension of H. 165, and Prof. Burnham had, unwittingly, made precisely the same mistake in 1901. Thus the latest observation of Herschel's No. 165 shows its position to be R.A. = 9h. 31m. 13s., dec. = +12° 25′ (1880), and its position angle and distance, at the epoch 1905·38, were 333°·1 and 2″·04 respectively.

In 1878 Prof. Burnham, observing in the position given by Herschel, saw a pair which was not identical with H. 165, and in the year 1902 was too faint for him to see. In 1901, repeating Herschel's mistake in the R.A., he observed the true H. 165, whilst in 1905 Prof. Doolittle found a similar pair to H. 165 in the same declination *south* and in the R.A. given in mistake by Herschel.

TYPE-WRITING BY TELEGRAPH.[1]

ONE of the most interesting papers read during the last session of the Institution of Electrical Engineers was that by Mr. Donald Murray on setting type by telegraph. Strictly speaking, the title of the paper is something of a misnomer, as the apparatus described by Mr. Murray was constructed for type-writing rather than type-setting; but as the principle is equally applicable to the latter process, it is unnecessary to be too critical. This is specially the case as the instruments and method were originally designed for the automatic telegraphic operation of linotype machines, and it was only because commercial considerations indicated the greater importance of the solution of the problem of telegraphic type-writing that attention was more particularly devoted to this question.

FIG. 1.—Keyboard Perforator with cover removed.

The problem which has to be solved is one of considerable complexity, as will readily be realised when its essential characteristics are considered. A message handed in at the transmitting station has to be translated into a series of signals which can be telegraphically transmitted over a single telegraph wire. These signals, on arriving at the receiving station, must actuate a receiving mechanism in such a manner that a particular set of signals produces a certain definite movement of the mechanism; thus the signals corresponding to the letter "a" must cause the striking (or equivalent) of the type-writer key "a," the signals corresponding to a notification of the end of a line must cause the shifting of the type-writer carriage ready for a new line, and so on. Now it is obvious that the signals as they are transmitted over the telegraph wire can only differ from each other by virtue either of their time arrangement or their magnitude. Each set of signals (corresponding to a letter) must be made up of one or more pulses of current, and one letter can only be distinguished from another by virtue of the pulses for the one being different in magnitude from those for the other, by their following one another at different intervals of time, or by their lasting for different periods of time; of course, also, a combination of any two or of all three of these may be used. It is not possible for the telegraphic signals to be differentiated in space unless more than one wire is used to connect the two stations. It is equally clear that the distinction between the signals in their final form is one of space, and this is so whether we consider the ultimate result, that is to say, the printed letter, or merely the alterations produced in the space relationship of the various parts of the printing mechanism which causes that mechanism instantaneously to print a particular letter. Thus we may say that what a type-writing telegraph has to do is the following:—it has to receive a message and translate it into a series of time or magnitude signals, to transmit these signals electrically over a wire, and to re-translate them into a series of space signals.

We have had occasion during recent years to describe several systems of telegraphy which aim at doing much the same thing as the Murray telegraph attempts, and it is of interest to compare the transmission methods used in these. Thus in the telautograph (see NATURE, vol. lxiv. p. 107) the actual handwriting of the original message is transmitted and reproduced, and this is done by a combination of space and magnitude signals. Two wires are used, and current pulses of varying magnitudes sent along them which reproduce at the receiving end the motion of a pen at the transmitting station. Here the time element of the signals has no effect, and a letter is reproduced equally if it be traced in one second or in one hour. In the Pollak-Virag system (see NATURE, vol. lxiv. p. 7) the telegraphic signals produce the motion of a beam of light which records in Roman letters the message transmitted. In this system the telegraphic signals differ from one another in their space relation and their duration. In the Murray system the signals differ from one another in their time relation.

We have pointed out that the first process is the translation of the message into a series of time signals, and for this purpose a time signal alphabet has to be chosen. Though this may at first sight seem a matter of secondary importance, it is in reality hardly too much to say that upon the suitability of the alphabet selected will depend, more than upon anything else, the chances of success of the system. This fact has been thoroughly realised by Mr. Murray and others who have worked upon this problem, with the result that an alphabet has been finally devised which seems to possess in the greatest degree possible all the more important advantages. In it every letter or other signal which has to be transmitted is represented by a series of five time signals; the alphabet is therefore an "equal letter alphabet," that is to say, each letter is composed of the same number of signal units (five in this case). The average number of units per letter is, of

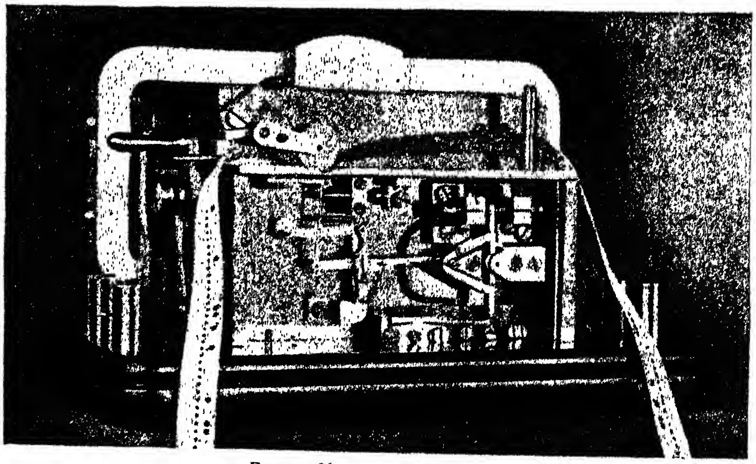


FIG. 2.—Single-line Transmitter.

[1] "Setting Type by Telegraph." By Donald Murray. (*Journal of the Institution of Electrical Engineers*, vol. xxxiv., pp. 555. 1905).

course, five; in the Morse alphabet the average number is thirteen; there is therefore an apparent advantage in time over the Morse code, but this may be more apparent than real, as the unequal length of the letters in the Morse code enables the shorter ones to be chosen for those letters occurring with the greatest frequency (such as E and T), so that the average number of units per message may be less than in an equal letter alphabet having a smaller average number of units per letter. Thus experience has shown that the actual average number of units per letter with the Morse code is only eight instead of thirteen. It must be remembered, also, that the Morse code is intended primarily for hand signalling, and consequently when time intervals are used the difference between any two which have to be distinguished manually or by ear must be fairly great. Thus the Morse dot consists of one unit, the Morse dash of three; were two units used for the dash instead of three, the distinction between the dash and dot would not be sufficiently marked. With machine telegraphy, on the other hand, there is no need to make such a great differentiation between the signals, as time intervals of one, two, three, and more units can all be distinguished, and in consequence it is possible to devise a shorter alphabet than the Morse code. It is not to be denied, however, that the use of a new alphabet is undoubtedly a disadvantage from the practical point of view, as it has to be learnt by the operators. This drawback is minimised by the fact that the operator does not print each signal separately as in operating a transmitting key; but it is nevertheless desirable, if not essential, that he should be able to read the message when printed on the transmitting tape.

To turn now to the apparatus used in the Murray system; the first operation, as in all automatic telegraph systems, is to punch the message to be transmitted on a paper strip or "tape." This is done by means of a key-board instrument of the ordinary type-writer form shown, with the cover removed, in Fig. 1. On the tape will be noticed a double row of holes, which can be seen more distinctly in Fig. 4; the row of small holes serves only to feed the tape forward, both in this machine and in the transmitter; the larger holes are the signals punched in the tape. The actual perforator can be seen in front; it is worked by an electromagnet which punches the necessary holes on the forward stroke and moves the tape one letter space (five holes) forward on its back stroke. On the right can be seen a lever which enables the tape to be pulled back letter by letter to make corrections; these are made by punching five holes, thus blotting out all the holes already punched, this signal (of five holes) leaving the receiving mechanism unaffected. It is thus possible to wipe out any part of the message incorrectly written on the tape, and so produce a tape which will give an absolutely correct message when transmitted; this is facilitated by the fact that the operator can see the tape as it is perforated, letter by letter. The speed at which this perforator can be worked is about 120 letters (twenty words) a minute. The transmission can be carried on five or six times as rapidly, so that five or six operators working at these perforators can produce enough tape to keep the transmission line full.

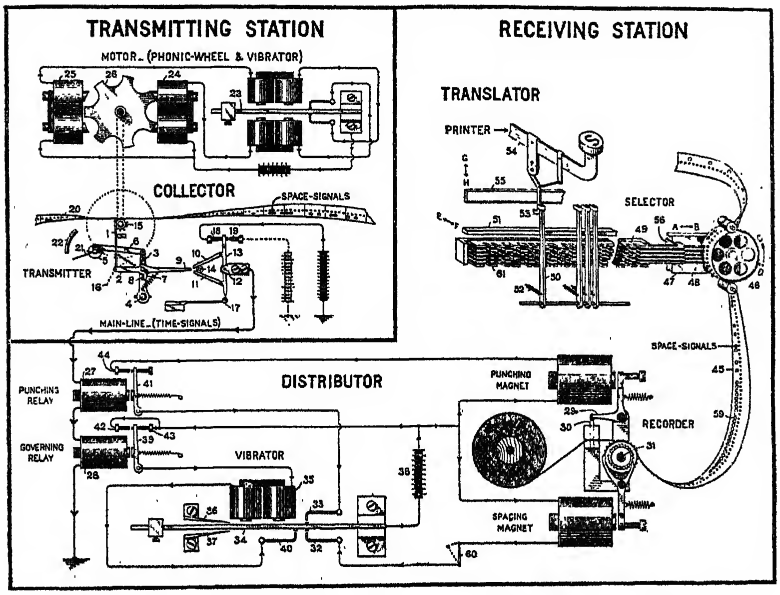


FIG. 3.—General Diagram of Murray Automatic Printing Telegraph System.

The automatic transmitter is shown in Fig. 2, and diagrammatically in Fig. 3 (collector). The tape is fed forward in the usual way by the star-wheel 15, passing across the end of an upright rod 1. This rod is pivoted as shown to the system of levers which oscillate about the centre 4, being kept in oscillation by the eccentric wheel 5, and making one oscillation for every unit on the tape. If this unit is a hole, the rod 1 enters this hole, the end 2 of the lever 2-9 is raised and the end 9 lowered, whereby the oscillation of the lever 3 brings the end 9 against the bar 11, thus pushing the contact lever 13 against contact 18. Here it remains until the next oscillation, and if this is the same as before, due to a second hole in the tape, it is not disturbed. It will thus be seen that successive signals of the same kind (either successive holes or successive spaces) are transmitted, not as intermittent, but as continuous signals. But if there follows a space in the tape the rod 1 cannot rise to its full height, the lever 2-9 is kept down at the end 2 and raised at the end 9, which comes in consequence against the rod 10 and forces the contact lever 13 over against contact 19, thereby breaking the punching current and sending spacing current into the line. The whole apparatus is driven by a phonic wheel motor in the usual way, the vibrating reed 23 sending currents alternately to the magnets 24 and 25, which keep the armature 26 in rotation. This is geared directly to the star-wheel 15, which has ten teeth, and is itself geared in the ratio of 10 : 1 to the eccentric wheel 5, so that the latter makes, as already stated, one revolution for every unit of the tape.

Now let us follow the message to its arrival at the receiving station, where the signals are caused to produce a second perforated tape, the exact duplicate of the first, by means of the mechanism grouped together in Fig. 3 under the title "distributor." The tape is fed forward unit by unit by means of the spacing magnet which operates the escapement 31, and holes are punched in the

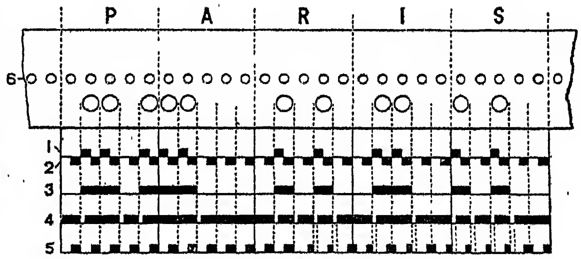


FIG. 4.

tape by the punch 30, which is operated by the punching magnet. If the circuits of these two magnets are followed out it will be seen that both are controlled by the vibrating reed 34 in such a way that they operate alternately according as the reed is against contact 32 or 33. It will further be seen that the punching magnet is also controlled by the punching relay 27, the circuit being open in the position shown, and closed when the reed 41 is against contact 44, *i.e.* when punching current is coming through the main line and punching relay. It will be noticed at once that the distributor cannot work properly unless the tongue 41 of the punching relay is in synchronism with the reed 34. To obtain this synchonism is the object of the governing relay 28, which is operated by the line current. The tongue of this relay vibrates between the contacts 42 and 43; when it is in contact with either the circuit of the vibrator magnet is closed, but during its passage from one to the other this circuit is opened. If this occurs whilst the contact 40 is open it can obviously have no effect on the oscillations of the reed, but if it occurs whilst this contact is closed it has the effect of diminishing the duration of the current in the vibrator magnet. The reed 34 vibrates against two springs 36 and 37, so that its time of vibration is capable of great control by the magnitude of the current in the vibrating magnet. By setting it so that its natural speed is a little too high, it is possible by means of the controlling action of the governing relay for perfect synchronism to be obtained. The action will perhaps be more readily understood by the diagram, Fig. 4. This shows a piece of the transmitting tape at the top punched with the signals for the word "Paris." In line 1 are shown the current impulses to the punching magnet due to the simultaneous closing of contacts 33 and 44. In line 2 are the regular intermittent current impulses to the spacing magnet due to the closing of contact 32. Line 3 shows the main line signals which, as pointed out in explaining the method in which the transmitter acts, are continuous and not intermittent. Line 4 shows the interruptions in the circuit of the vibrator magnet caused by the vibration of the reed of the governing relay which occurs at the beginning and end of every signal in line 3. In line 5 are the actual current pulses in the vibrator magnet due to the closing of contact 40. These are shown in step at the beginning, but gradually falling out of step, whereby, as will be seen, they are diminished by the interruptions shown in line 4, and are thus automatically brought back into step.

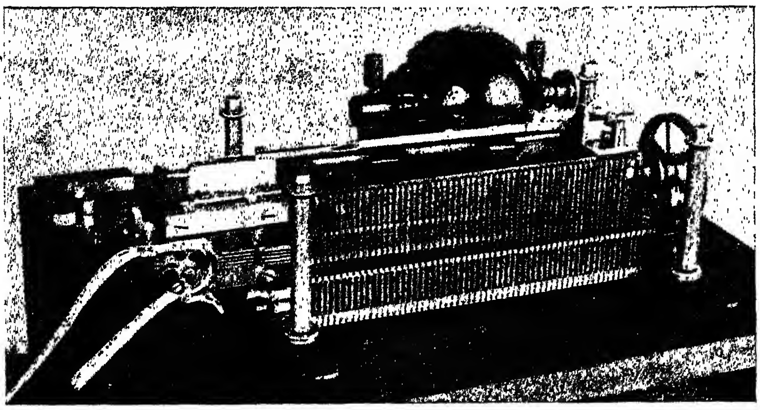


FIG. 5.—Murray Printer with Typewriter removed.

The only remaining operation is to use the tape 45 (Fig. 3) to work either a type-writer or a type-setting machine. The Murray printer with the type-writer removed is shown in Fig. 5, and diagrammatically in Fig. 3. It will not be necessary to describe it in detail; the principle is that of the ordinary lock and key. The tape is fed forward letter by letter by means of the star-wheel 46; the reciprocating shuttle 47 carries a die-block, which allows the five rods 48 to pass through the perforations in the tape when these are present. According as one or more of these rods passes through the tape, a particular set of slots in the combs, 49, attached to the rods is brought into line, the corresponding lever 50 is pulled into the channel thus formed, and the corresponding type-writer key is depressed.

The complete set of Murray apparatus is shown in Fig. 6. On the extreme right is the perforator, next to it on the left the automatic transmitter, then on the same table the distributor in front and the relays behind. The translator and type-writer are on the small table at the left. We have only been able to give a brief description of the most important features of this very ingenious system; there are numerous points of detail which space does not permit us to describe. The system has been on trial for some time both in this country and abroad, and has met with considerable success; it is now in use on several English lines. There can be no question after the perusal of Mr. Murray's paper that it possesses many advantages over its forerunners which should enable it to survive. It is stated that the automatic part of the apparatus can be run perfectly up to 200 words (1200 letters) a minute, but that no type-writer will stand the strain of being run at this speed, a maximum of 120 words being all that is allowable. It is, however, obviously possible to run the automatic part at top speed if necessary, and use two type-writers at the receiving end in the same way as at the transmitting end.

MAURICE SOLOMON.

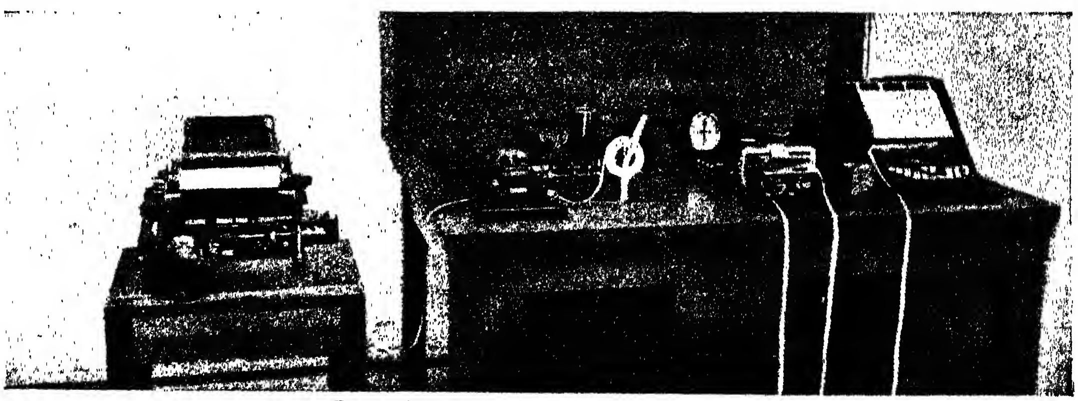


FIG. 6.—General View of a Set of Murray Apparatus.

THE PERCY SLADEN EXPEDITION IN H.M.S. SEALARK. THE CHAGOS ARCHIPELAGO.

OUR arrival in Mauritius on August 5 completed the first half of our cruise in H.M.S. *Sealark*, together with all our work directly connected with the Chagos Archipelago. This work may be divided under two heads, oceanography and biology. The former has been carried out mainly by Commander Boyle Somerville and his officers in view of the scientific objects of the expedition, but at the same time it is all of practical value for navigation in these waters. In many respects it has been of a singularly arduous nature; surveys by camping parties and deep soundings from the ship have been carried on simultaneously, together with numerous observations on the tides, currents, sea temperatures, &c. To a considerable degree it and all the work has been hampered by the heavy weather, which, contrary to all expectation, we have experienced, winds from south to east with heavy, confused seas, partially induced by the comparatively shallow waters of the Chagos Archipelago, and partially due to the current, which set in an easterly direction (against the wind) during the whole time we were in the group.

It is almost too soon to attempt to summarise any of the results of the cruise, but the soundings taken on our course from Ceylon to the Chagos and from the latter to Mauritius show that the archipelago is closely surrounded, both to the north and west, by the 2000-fathom line, and that there is at the present day no trace in the topography of the Indian Ocean of any former connection of the group with either the Maldives or the banks on the Seychelles-Mauritius line. The Chagos Archipelago appears, indeed, to stand by itself, being built up on a plateau rising to a depth of 800 fathoms in an ocean of an average depth of 2300 fathoms. Previously there were no bottom soundings between the banks and shoals of the group, but now a large series (more than 100) have been run, showing depths of 400 fathoms to 800 fathoms between the individual banks; from most of these a sample of the bottom has been obtained.

Broadly speaking, the Chagos group may be said to consist of three atolls to the north (Salomon, Peros Banhos, and Blenheim), the Great Chagos Bank in the centre (60 miles by 90 miles), and to the south two atolls, Diego Garcia and Egmont, besides certain submerged banks both to the north and south. Of these, H.M.S. *Sealark* has re-charted Salomon and parts of Peros Banhos, while Cooper and I have in addition examined the southern atolls. Salomon was very carefully surveyed, our intention being to make a comparison between its condition at the present time and when Powell's chart was made in 1837. The latter chart, however, proved to have been so carelessly drawn that any close comparison is, I fear, useless, but the new chart should be of great value when it is possible to re-examine the atoll at some future date. Its section lines show that it arises in the last 400 fathoms by similar slopes to those of Funafuti, but it is a much simpler atoll, having only one passage, and more than half its reef crowned by land. Our numerous soundings and dredgings on its slopes leave no room for doubt but that its present reef is extending outwards on every side on its own talus, in fact, that the steep found round it (and, indeed, most atolls) is, *in this instance*, simply the slope at which coral and other remains from the reef above come to rest in the water. Its face was everywhere singularly barren; Lithothamnion, Polytrema, and, of course, reef-corals were not obtained below 50 fathoms. Further out, at 250 fathoms and over, the bottom was smooth and barren; the lead constantly failed to bring up any samples, while the somewhat broken and dented, but almost empty, dredges gave the idea of bare rock with a little muddy sand here and there. Indeed, our evidence points to the impossibility of any upward growth being in progress between the different Chagos banks, and to the probability of considerable current being felt even at 500 fathoms.

The reefs of the Chagos are in no way peculiar save in their extraordinary paucity of animal life, to which I referred in my last letter. Green weed, too, of every sort is practically absent. However, this barrenness is amply compensated for by the enormous quantity of nullipores (Lithothamnia, &c.), incrusting, massive, mammillated, columnar, and branching. The outgrowing seaward edges of the reefs are practically formed by their growths, and it is not too much to say that were it not for the abundance and large masses of these organisms there would be no atolls with surface reefs, &c., in the Chagos. The lagoon shoals of Egmont are covered by them, and alone reach the surface; having once done so they die and become hollowed out in the centre, finally resembling miniature atolls.

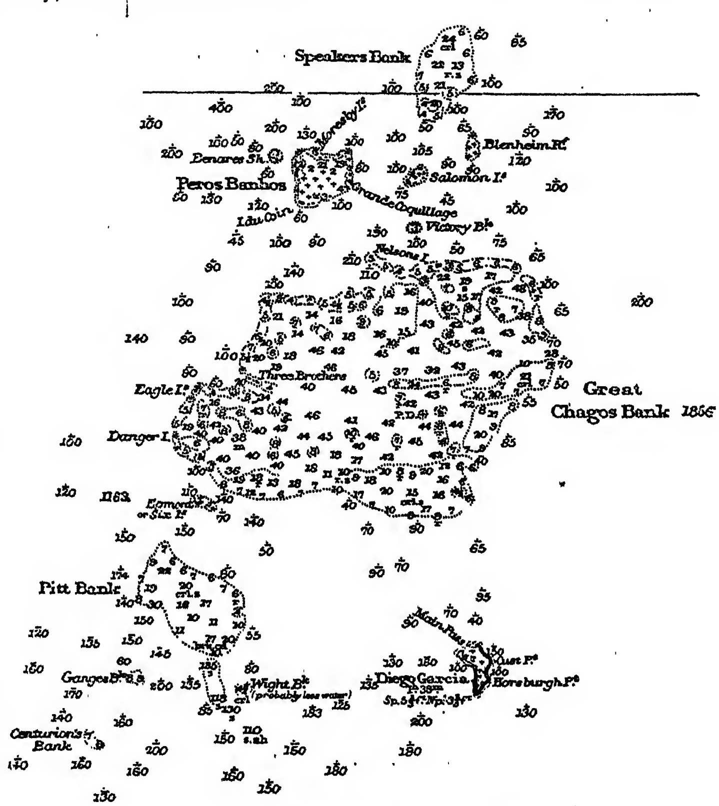


FIG. 1.—Chart of the Chagos Archipelago.

In such a large group the conditions of the encircling reefs against the lagoons naturally vary very considerably. In general their inner edges reach the surface, and in the more open atolls the lagoon slope to 10 fathoms closely resembles the seaward slope. The bottoms of the lagoons are bare, rock, hard sand or mud, with shoals arising precipitously here and there, built up by a few species of coral, but largely covered by Xenia and Sarcophytum (as also are the only two submerged banks, Wight and Centurion, which we examined). Diego Garcia lagoon differs somewhat owing to its being almost completely surrounded by land. It has perhaps the most varied fauna in the group, and alone gives definite evidence of enlarging in every direction. Everywhere the land is entirely of coral origin. Diego Garcia shows signs of a recent elevation of a few feet, the present single island having been formed by the joining up of a series of separate islets on an elongated reef. The kuli or barachois (large shallow lakes) of the same island owe their origin to the same elevation, though elsewhere in the group they are generally due to

the successive washing up of beaches from the sea, enclosing areas of the reef. On the whole, there is singularly little change since the survey in 1837, and my impression is that Chagos has been for a long time an area of rest, and that the *present* condition of its reefs is mainly due to agencies still in action.

We have now examined the marine fauna in Salomon, Peros Banhos, Diego Garcia, and Egmont, and I would again lay stress on its comparative paucity and lack of variety as compared with the Maldives, Fiji, or even Funafuti, though many of the forms are very common. In short, its general character is rather that of the temperate than of the tropical zone.

The land fauna is largely dependent on the flora, and the latter, except on small isolated islets and selected positions, has been destroyed to allow of cocoanuts being planted. The shores are everywhere fringed with *Scaevola koenigii* and *Tournefortia argentea*, both covered with a climbing bean. Behind these there was originally a forest formed of immense mapon (*Pisonia capidia*) and takamaka (*Calophyllum inophyllum*), with a few cocoanuts, Barringtonia, banyans, and other smaller trees, and an undergrowth largely consisting of immense Asplenium and other

FIG. 2.—Lithothamnia on the Seaward Reef of Salomon Atoll, Chagos Archipelago

ferns and Psilctum, herbaceous dicotyledons being confined to the more open, dry, sandy, and stony parts; mangroves and Pandani are, curiously enough, not found. With the assistance of Dr. Simpson, we have collected the flora of each of the atolls, obtaining more than 600 specimens, about 140 species, of which probably only half are indigenous.

Of mammals there are only rats and mice, but there are traditions of dugong as well. Of birds the cardinal, sparrow, and mina have doubtless been introduced; noddies, frigates, and terns were breeding in enormous numbers on certain islands, though it was mid-winter; crab-plover, curlew, whimbal, and a sandpiper were common, and in the north-west monsoon buzzards, kites, and crows are said to be regular visitants. The green and shell turtles (*Chelone mydas* and *C. imbricata*) abound, the former coming on shore to deposit its eggs at night and the latter in the daytime. The only other reptiles are a marsh tortoise, perhaps introduced from Madagascar, and geckoes; there are no Amphibia. There is only one land shell, and arachnids and myriapods are scanty; the land crustacea are similar to those of the Maldives, but the coco crab (*Birgus latio*) is also abundant. Mr. Bainbrigge Fletcher has sorted the insects and finds about 110 species, most of which are probably indigenous; but the best season for the group would be in the rather hotter and damper north-west monsoon. On the whole, the land fauna and flora is much what one would expect to get, regarding the Chagos as a group of purely oceanic islands.

We expect to leave Mauritius toward the end of August for Cargados, Agalegas, and the submerged banks towards the Seychelles. Our cruise will be largely a dredging one, but the examination of Agalegas should be interesting. Meanwhile, Cooper and I hope to see some of the reefs round Mauritius.

J. STANLEY GARDINER.

IRON AND STEEL INSTITUTE.

FOR the first time the autumn meeting of the Iron and Steel Institute was this year held in Sheffield. An elaborate programme of visits to works and social functions was arranged, and no less than 1500 members and ladies were present, including members from all parts of the world. The opening meeting was held at the new university on September 26 under the presidency of Mr. R. A. Hadfield. Addresses of welcome were delivered by the Lord Mayor, the Master Cutler, the Vice-Chancellor of the University, Colonel Hughes (chairman of the reception committee), and by the president of the Sheffield Trades and Labour Council on behalf of the working men. Mr. Hadfield, in reply, thanked the reception committee for the admirable work it had done, and gave an interesting historical review of the Sheffield steel trade. Incidentally, he mentioned that the membership of the Iron and Steel Institute had now risen to 2200. After the reading of the minutes of the last meeting by the secretary, Mr. Bennett H. Brough, and the transaction of other routine business, the papers submitted were read and discussed. In the first paper taken Prof. J. O. Arnold described the department of iron and steel metallurgy at the University of Sheffield. The main object borne in mind in designing the laboratory was the erection on a manufacturing scale of plant producing steel by the crucible, Bessemer, and Siemens processes.

Prof. J. O. Arnold and Mr. A. McWilliam next contributed an important paper on the thermal transformations of carbon steels. For the research three steels were selected, saturated with 0.89 per cent. of carbon, unsaturated with 0.21 per cent. of carbon, and supersaturated with 1·78 per cent. of carbon. In the case of the unsaturated steel, the authors find that above Ar 3 (810° C.) the ferrite and hardenite are in mutual solution as a homogeneous mass. The Ar 3 change is accompanied by a segregation of the two constituents, which, if the cooling be slow, is probably completed in the Beta range of temperature. After a fairly rapid cooling from 950° C. the 0·21 per cent. carbon steel when quenched at 730° C. micrographically registered a segregation of ferrite so far advanced as strongly to suggest that such segregation must have begun at Ar 3 and not at Ar 2. In other words, hardenite is insoluble in ferrite in both the Beta and Alpha ranges of temperature. It however still retains its identity as hardenite whilst falling through, say, 30° C. or 40° C. of temperature in the Alpha range, namely, from the end of Ar 2 at about 720° C. to the beginning of Ar 1 at about 680° C., at which latter temperature it begins to decompose into pearlite. The heating transformations of this steel are substantially as follows:—At Ac 1 (about 710° C.) in the Alpha range the pearlite begins to change into hardenite, hence the carbide is soluble in the

Alpha range. The change to hardenite is somewhat advanced when Ac 1 merges into Ac 2 at about 720° C. owing to these points always overlapping in the heating curve. The hardenite areas probably remain unchanged on the sites previously occupied by the pearlite until the Gamma range Ac 3 is reached (at about 810° C.), when the hardenite and ferrite dissolve into each other, forming a homogeneous molecular mixture. In a saturated steel there is, on heating, a single absorption of heat at the change point Ac 1, 2, 3, the amplitude of which ranges from about 710° C. to 730° C. This change marks the transformation of the whole mass from pearlite into hardenite. On cooling, there is a very considerable evolution of heat at the single point Ar 1, 2, 3, the amplitude of which ranges from about 690° C. to 660° C. This recalescence marks the transformation of hardenite into pearlite. The particular phase of pearlite obtained depends upon the rate of cooling from 660° C. to atmospheric temperature. The emulsified phase is produced by very rapid cooling, normal pearlite by ordinary cooling, and laminated pearlite by very slow cooling. Pearlite, in which the carbide is emulsified or "sorbitic," may also be produced by tempering hardenite. The micrographic and thermal transformations of a supersaturated steel are as follows:—At Ac 1, 2, 3 the sectional ground mass of pearlite changes to hardenite, the cementite slowly segregates into larger masses until a temperature of about 900° C. is reached, then the cementite and hardenite dissolve one into the other, and a homogeneous mass of hardenite and cementite is obtained. On cooling, at about 900° C. the cementite falls out with a faint evolution of heat, and is completely segregated long before the point Ar 1, 2, 3 is reached, hence the micrographic transformations of cementite and hardenite are quite unconnected with the three thermal critical points or any of them, and are due entirely to the influence of temperature.

Mr. A. W. Richards and Mr. J. E. Stead, F.R.S., read a paper on overheated steel, describing experiments supplementing their previous work on the subject, and showing that re-heating overheated good steel can be relied upon to restore good properties to brittle material. Steel initially bad, brittle, and dangerous owing to irregularity in the distribution of the elements cannot, however, be made good by any kind of heat treatment.

Mr. L. Guillet (Paris) contributed a paper on the special steels used for motor-car construction in France. Steels with low percentages of carbon and nickel are used for parts which require case hardening and quenching. Steels with medium percentages of carbon and low percentages of nickel are used after quenching and re-heating for a large number of parts. Steels low in carbon and high in nickel are used for valves. Chromium steels with high carbon and low chromium are used for bearings. Silicon steels are used for springs and for gearing. Nickel chromium steels are used for numerous parts requiring resistance to shock.

Mr. Guillet also submitted an exhaustive paper on the use of vanadium in metallurgy. Vanadium improves the properties of alloys. In normal steel it increases the tensile strength and elastic limit, and in quenched steel it acts in the same way without increasing the brittleness. Vanadium is certainly the element which, together with carbon, acts with the greatest intensity in improving alloys of iron.

The paper read by Mr. B. Talbot (Middlesbrough) on segregation in steel ingots was one of great interest, as, although attention has been directed to the effects of segregation, little has been published as to means of lessening the amount of such segregation. The author's investigations, in which parallel tests have been made on ingots from the same heat with and without the addition of a small amount of aluminium, are of special value. The ingots were obtained from both acid and basic open-hearth furnaces, and were 5 feet 6 inches in height, the drillings for analysis being taken over the whole surface of the divided ingot. When no aluminium was added excessive segregation down the central line of the ingot occurred from 6 inches from the top to about half way down the ingot. Sulphur is the element that tends to segregate most, phosphorus next, then carbon, and finally manganese. With the use of aluminium, a billet of much more regular composition is obtained.

Mr. Douglas Upton (Jarrow) described an ingenious mechanical device for handling steel bars during the process of manufacture.

Mr. L. Dumas (Paris) read a lengthy paper on the reversible and irreversible transformations of nickel steel. The starting point of the investigation was Prof. John Hopkinson's well known experiment in 1889. Nickel, manganese and carbon, introduced into a steel, the author finds, determine alike the appearance of the same phenomenon, irreversible transformation, which is the more intense the higher the proportions in which they are present. They must also be in solution, a state which is often, as regards carbon, impossible of attainment without the aid of chromium. The nickel steels which have not undergone transformation, although too costly to be of industrial use, are of great interest as showing the result of adding nickel to steel. The homogeneity is increased, and the proportion of β-iron intensified.

Mr. G. B. Waterhouse (New York) submitted a paper giving the results of the investigation of a series of steels of constant nickel with varying carbon percentages. The results showed that nickel raises the tenacity without materially lowering the ductility. Annealing lowers the tenacity without greatly raising the ductility. Nickel lowers the transformation points Ar 3, 2 and Ar 1 about 20° for every 1 per cent. of nickel.

Captain H. G. Howorth, R.A., contributed a paper on the presence of greenish coloured markings in the fractured surfaces of test-pieces. The attention of the Ordnance Committee was directed to defects of this kind in test-pieces from tubes for guns, and the object of the paper was to ascertain to what extent the presence of such defects should weigh in accepting or rejecting the forgings for this purpose. The flaws appear to be due to slag, and in any forging subject to violent alternating stresses these flaws in prolongation may easily develop into cracks. Interesting contributions to the discussion were made by General O'Callaghan, president of the Ordnance Committee, and by General Sir J. Wolfe Murray, Master-general of the Ordnance.

Mr. Thomas Andrews, F.R.S., contributed a paper on the wear of steel rails on bridges. He received from a railway company the fractured portions of an acid Bessemer steel rail which had broken in main line service after eleven years and five months' service on a bridge. It had borne 148,000,000 tons of passing traffic, and had lost 0.69 lb. per yard per annum in weight. One of the chief causes of the fracture has been the defective segregated chemical composition of the rail. The percentages of combined carbon and manganese, found in the top of the rail head and in the bottom flange, were in excess of what should obtain in good rail steel. The chemical composition was an undesirable one, and such as is liable to lead to brittleness and sudden fracture in rail service. The high-power microscopic examinations confirmed the results arrived at by the chemical analyses and physical tests, and they demonstrated the non-uniformity of the physical and crystalline structure of the rail. The microscopic examinations have also shown the undesirability of employing rails having too high a percentage of combined carbon and manganese, and they have indicated that great care should be exercised in the thermal treatment of rails, from the ingot to the finished rail, in order to obtain a suitable microcrystalline structure resulting in a good durable rail.

The existence of troostite can no longer be questioned, but opinions as to its nature are divided. Dr. C. Benedicks (Upsala), in a paper on the subject, expressed the view that troostite is a pearlite with ultra-microscopically small particles of cementite. In all probability troostite is formed by a transformation *in situ* of martensite.

Prof. E. D. Campbell (Michigan University) contributed a paper on the occurrence of copper, cobalt, and nickel in American pig-irons. The percentages varied in the specimens analysed from 0.011 to 0.039 of copper, from a trace to 0.048 of cobalt, and from a trace to 0.072 of nickel. The only two irons containing any considerable amount of cobalt and nickel possess valuable properties for car-wheel castings.

ELECTRONS AND MATTER.

THE inaugural address on "Electronen en Materie," delivered by Prof. C. H. Wind upon taking the chair of mathematical physics and theoretical mechanics at the University of Utrecht on February 20 of this year, has lately been published (Leyden: A. W. Sijthoff). Beginning with a brief account of the gradual development of the conception of electrons, mainly through the works of H. A. Lorentz, and of its sudden corroboration after the discoveries made by Zeeman and Röntgen, the address goes on with an exposition of the notions of ether, electric displacement, electrons, and magnetic force in their present form, and traces the way to the idea of an electromagnetic mass of the electrons.

The measurements made by Kauffmann, though showing that these particles of matter probably do not possess any mass besides this electromagnetic one, of course do not prove that the same should be the case with all other particles of matter in our universe, as Wien had suggested. Yet they make this suggestion—the basis of what the author calls an electron theory *à outrance*—to some extent a plausible one. Several of the brilliant and fascinating views which this ultimate theory opens having been expounded by Mr. Balfour in his presidential address at the Cambridge meeting of the British Association, the present author directs attention to those concerning the structure of atoms, mechanism of radiation, and origin of chemical differences. He also enters into some more details, and, assuming for a while that an atom of hydrogen consists of a single positive and a single negative electron, calculates that in this system the two components would be separated by a distance perhaps 100,000 times greater than the diameter of the largest of them, and that there must be stored up in the atoms constituting one gram of hydrogen an amount of energy equivalent to that required by a mail steamer to cross the Atlantic ten times.

Poincaré has raised several serious objections against the theory. Some of these relate to the *temperate* electron theory only, and lose their weight as soon as the *ultimate* theory is adopted. To take an example. Poincaré does not feel satisfied with the changes of length in solid bodies owing to their motion through ether, as suggested by Lorentz and by Fitzgerald in order to explain the result of Michelson's experiments. Lorentz himself, however, has already shown that this hypothesis, though appearing rather bold at first sight, becomes plausible as soon as molecular forces and masses are supposed to be in the same way as electromagnetic ones affected by a translation through ether; and it is clear that this supposition is involved in that of all matter consisting of electrons, which therefore at once clears the way.

The second category of objections, those arising from the dependency of electromagnetic mass upon velocity and direction of motion, from so many instances of unequal action and reaction, from the violation even of the law of inertia, whenever electrons move with a higher speed than light, are, on the other hand, most serious in the light of the *ultimate* electron hypothesis, whereas the *temperate* theory has a way left open to dispose of them. The latter theory, indeed, does not deny the existence of matter apart from electrons and considers electromagnetic mass as something secondary. By assuming as constituents of ether hidden matter, obeying the classical principles just as well as ordinary or coarse matter, this theory will be able to account for every apparent deviation from the principles which by mathematical reasoning should be deducted as occurring in coarse matter.

But if by progress of experiment and theory the electron hypothesis in its *ultimate* form should continue to gain ground, if it should finally prove unavoidable to accept the view that matter consists entirely of electrons, then mass and momentum would cease to be what they are now in our ideas, quantities strictly invariable. There is no denying that this would involve a serious change of our general conception of nature. For the predilection and confidence with which science has for centuries been aiming at a description of the physical universe in terms only of matter and motion were based chiefly—though half unconsciously—on the idea of mass and momentum being invariable elements of nature, images or pictures of invariable elements of reality itself. Now this idea, so fundamental to our whole mechanical conception of nature, would shrink into an illusion in the light of the new theory. Of course, there would be a great advantage also. Whereas it seems now almost hopeless to involve electromagnetic phenomena in a description in terms only of matter and motion, the unity desired in our picture of the physical world would then be secured by putting it in terms of electrons and motion.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

WE learn from *Science* that an anonymous gift has been made to the Lebanon Valley College, Annville, Pa., of a hall of science to cost 16,000*l.*

MR. F. R. B. WATSON has been appointed assistant lecturer and demonstrator in engineering at the Merchant Venturers' Technical College, Bristol.

A REUTER message from New York states that the American General Education Board has received from Mr. John Rockefeller cheques to the amount of 2,000,000*l.*, in pursuance of his promise last June to give that amount in cash or securities for the endowment of higher education.

A PRIZE of 50*l.* out of the Gordon-Wigan fund will be awarded at the end of the Easter term, 1906, for a research in chemistry, of sufficient merit, carried out in the University of Cambridge. The research may be in any branch of chemistry. The dissertation, with the details of the research, must be sent to the professor of chemistry not later than the division of the Easter term, 1906.

THE year-book of the faculty of engineering of the University of Liverpool (1905–6) shows that the courses of study are so arranged as to afford a general scientific training for those intending to become engineers. The honours course affords opportunities for specialisation in a selected branch of the profession. The university training, which extends over three years, is preliminary to or supplementary of pupilage under an engineer or apprenticeship with an engineering firm.

IT is announced in *Science* that the University of Pennsylvania will receive 12,000*l.* from the estate of the late Prof. Maxwell Sommerville, who held a chair of archæology in the university. President Thwing, of Western Reserve University, we learn from the same source, has announced that Mr. Andrew Carnegie has given 5000*l.* towards the establishment of a fund of 20,000*l.* for the endowment of a chair of political economy at Western Reserve University, to bear the name of the late Senator Hanna.

THE *Engineering and Mining Journal* publishes the presidential address delivered by Mr. F. W. McNair before the Society for the Promotion of Engineering Education, in which he shows that the American mining schools have amply proved the necessity for their existence. From statistics of the six largest mining schools in America, he shows that the ratio of graduation to enrolment is increasing, that there is an enormous percentage increase in students enrolled, and that the mining school product is gradually taking the place of the so-called practical man. Dividing the twelve years available for comparison into three periods of four years, it is shown that the schools under consideration graduated one man to 13·6 million tons of the total mineral production during the first period, one to 10·2 millions in the second period, and one to 9·4 millions in the last period.

IN connection with the department of geography of the University of Cambridge, special public lectures will be delivered in the Michaelmas term by Sir Clements R. Markham, K.C.B., F.R.S., and Sir Archibald Geikie, F.R.S. The following courses, which are open to all students, whether members of the university or not, have also been arranged:—A general course in geography (with practical work) will be given by Mr. H. Yule Oldham; courses on the geography of Europe, on the principles of physical geography, and on the history of geographical discovery will also be given by Mr. Oldham. Dr. J. E. Marr, F.R.S., will lecture twice weekly on geomorphology; Dr. A. C. Haddon, F.R.S., will give courses on ethnology and on anthropogeography; and Mr.

A. R. Hinks will lecture on geographical surveying (with field work). The duties of the board of geographical studies, which is responsible for the general administration of the department, include the promotion of geographical study and research within the university, the provision of instruction in the several branches of geographical science, the administration of the geographical education fund, and the publication of schedules defining the range of the geographical examinations for degrees and diplomas of the university in geography.

THE development and strengthening of the relation which the work of technical institutes and evening classes bears to the practice and commercial aspects of our industries are undoubtedly necessary parts of further industrial progress. For this reason we welcome a recent circular issued by the Board of Education to the inspectors of these educational institutions. The Board recognises the existence of a great variety in the character and amount of the cooperation between employers of labour on the one hand and the managers of technical institutions and evening schools on the other, and in its circular gives a short account of a few typical examples with a view of showing inspectors and others the kind of work which can be done with advantage in this direction. It is true that the details of such cooperation must vary from place to place in accordance with the special requirements of each important industry, but unless it exists in one form or another full advantage will not be derived from our expenditure on technical education. The circular proceeds to give a helpful *résumé* of what has been done to encourage artisans in their studies by means of the payment of fees and the award of prizes, by increases of wages, by allowances of time for attendance at classes, and by providing opportunities for higher instruction. The circular may be commended to all employers of labour who desire that the workmen of this country may be put into the way of competing on equal terms with those of other countries.

ON Friday last Lord Rosebery, as Chancellor of the University of London, opened the Goldsmiths' College at New Cross, formerly the Goldsmiths' Institute. The development of Polytechnics under the London County Council led the Goldsmiths' Company to reconsider the constitution of the institute, which had been carried on by the company since 1888; and last year the buildings were presented by the company to the University of London, with an unoccupied adjoining site of four and a half acres, and an endowment of 5000*l.* a year for five years. An additional sum of 5000*l.* was given by the company to enable the university to carry on evening classes during 1904–5, in cooperation with the London County Council. Under the new scheme the institution has become the Goldsmiths' College, University of London, and its functions are chiefly those of a day training college for elementary teachers. These students will take the ordinary two years' course provided by the regulations of the Board of Education, and will not prepare for a university degree; but the evening class work in science and engineering will still lead up to university degrees. In the course of his remarks at the opening ceremony, Lord Rosebery said:—"The University of London is spreading itself over the metropolis. It is not too much to say that, though we cannot say that it will soon spread itself over the Empire, we may at least say that it will very soon appeal to every portion of the Empire. It is a young university. It deals with comparatively new branches of learning. It deals with the practical and the concrete, rather than with the ancient and the abstract. In that respect there is a marked difference between it and those ancient universities to which some of us owe a loyal and filial allegiance which cannot be obliterated by any newer loyalty or allegiance. The newer universities must be content, and wisely content, with something which is not antiquity, and is not tradition, but may be more immediately useful and practical than either antiquity or tradition. We, placed in the largest community in the world, with our hands, so to speak, on the very heart of the Empire, living among new wants and new aspirations, meeting new needs and new acquirements, ready, as I hope, to face the exigencies of to-day and to-morrow, are the university of the future, though we cannot trace our antiquity back to the hoary past."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 8.—"The Synthesis of a Substance allied to Adrenalin." By H. D. **Dakin.** Communicated by Prof. E. H. Starling, F.R.S.

The paper contains an account of attempts to synthesise adrenalin—the physiologically active principle of the suprarenal gland. Adrenalin is commonly regarded as a secondary alcohol of the formula

$$C_6H_3(OH)_2.CH(OH).CH_2NHCH_3.$$

The corresponding ketone may be prepared by acting upon chloracetylcatechol with methylamine, and is a crystalline substance forming stable crystalline salts. The ketone may be reduced electrolytically, and the product may have the structure assigned to natural adrenalin. Although the synthetical base has many chemical and physiological properties in common with adrenalin, it probably is not the racemic form of the latter substance. The base forms extremely deliquescent salts which are unstable in hot solution; on addition of ammonia to aqueous solutions of the salts, the free base is precipitated in the form of a grey-white amorphous precipitate which is extraordinarily unstable in the dry state. Owing to experimental difficulties, satisfactory analytical and molecular weight determinations have not yet been made.

A close physiological relationship between the natural and synthetical bases is shown by the fact that, in the case of a rabbit, intravenous injection of less than 0·000001 gram is followed by a marked rise in arterial blood-pressure.

A base which is probably identical with the substance above described has been obtained by acting upon methylaminoacetylcatechol with aluminium and mercuric sulphate (D.R.-P. 157,300), and it is assumed to be a secondary alcohol. If this be correct, the formula for natural adrenalin will require modification, but more experimental evidence is needed before the question can be settled.

July 1.—"On the Influence of Collisions and of the Motion of Molecules in the Line of Sight, upon the Constitution of a Spectrum Line." By Lord **Rayleigh,** O.M., F.R.S.

Apart from the above and other causes of disturbance, a line in the spectrum of a radiating gas would be infinitely narrow. A good many years ago,[1] in connection with some estimates by Ebert, the author investigated the widening of a line in consequence of the motion of molecules in the line of sight, taking as a basis Maxwell's well known law respecting the distribution of velocities among colliding molecules, and he calculated the number of interference bands to be expected, upon a certain supposition as to the degree of contrast between dark and bright parts necessary for visibility. In this investigation no regard was paid to the collisions, the vibrations issuing from each molecule being supposed to be maintained with complete regularity for an indefinite time.

Although little is known with certainty respecting the genesis of radiation, it has long been thought that collisions act as another source of disturbance. The vibrations of a molecule are supposed to remain undisturbed while a free path is described, but to be liable to sudden and arbitrary alteration of phase and amplitude when another molecule is encountered. A limitation in the number of vibrations executed with regularity necessarily implies a certain indeterminateness in the frequency, that is, a dilatation of the spectrum line. In its nature this effect is independent of the Doppler effect—for example, it will be diminished relatively to the latter if the molecules are smaller; but the problem naturally arises of calculating the conjoint action of both causes upon the constitution of a spectrum line. This is the question considered by Mr. C. Godfrey in an interesting paper,[2] upon which it is the principal object of the present note to comment. The formulæ at which he arrives are somewhat complicated, and they are discussed only in the case in which the density of the gas is reduced without limit. According to the view of the

[1] *Phil. Mag.*, vol. xxvii., p. 298, 1889; "Scientific Papers," vol. iii., p. 258.

[2] "On the Application of Fourier's Double Integrals to Optical Problems," *Phil. Trans.*, A, vol. cxcv., p. 329, 1899.

present author, this should cause the influence of the collisions to disappear, so that the results should coincide with those already referred to where the collisions were disregarded from the outset. Nevertheless, the results of the two calculations differ by 10 per cent., that of Mr. Godfrey giving a *narrower* spectrum line than the other.

The difference of 10 per cent. is not of much importance in itself, but a discrepancy of this kind involves a subject in a cloud of doubt, which it is desirable, if possible, to dissipate. Mr. Godfrey himself characterises the discrepancy as paradoxical, and advances some considerations towards the elucidation of it. The present author has a strong feeling, which he thinks he expressed at the time, that the 10 per cent. correction is inadmissible, and that there should be no ambiguity or discontinuity in passing to the limit of free paths infinitely long. In connection with some other work he has recently resumed the consideration of the question, and he is disposed to think that Mr. Godfrey's calculation involves an error respecting the way in which the various free paths are averaged. A discussion of the subject is given in this paper.

PARIS.

Academy of Sciences, September 25.—M. Troost in the chair.—On the origin of the principle of virtual displacements: P. **Duhem**. Descartes proposed to found his system of statics on the proposition "It requires the same power (*puissance*) to raise a given weight a fixed height as to raise a weight K times as great to a height K times less." M. Duhem has found that this principle was first implicitly used by Jordanus de Nemore, in his *Tractatus de ponderibus*, dating from the thirteenth century, and traces its use by various writers down to the time of Descartes in 1637.—Observation of the total eclipse of the sun of August 30, made at Robertville, Algeria: M. **Salet**. The plan of work included (1) a search for the existence of a magnetic field in the neighbourhood of the sun by the observation of the deviation of the plane of polarisation of the coronal light; (2) the photographic study of the distribution of the polarised light of the corona; (3) the study of the atmospheric polarisation; (4) the spectro-polarisation of the corona; and (5) the photography of the ultra-violet spectrum of the corona. A *résumé* of the results, which were successful, is given.—On the observations of the total eclipse of the sun of August 30 made at Guelma by the commission from the Observatory of Algiers: Ch. **Trépied**. The results obtained include the confirmation of the supposed relationship between coronal structure and the state of solar activity, the photographic impression of the moon's disc on the corona apart from totality, the photographic registration of a very curious phenomenon of elliptical rings, and a negative exposed during the whole of totality permitting of the study of the greatest photographic extension of the corona during this eclipse and of contributing to the elucidation of the question of the intra-Mercurial planets.—New researches on the reproductive apparatus of the Mucorineæ: J. **Dauphin**. The formation of the mycelium has been followed with the microscope, day by day, up to the production of the reproductive organs. The effect of varying the nature of the carbohydrate present in the culture medium was studied, and observations made with raffinose, dextrin, starch, dulcite, erythrite, glycerin, ordinary alcohol, salicin, and quercite.—On the sensibility of the chlorophyll apparatus in ombrophobe and ombrophile plants: W. **Lubimenko**. The facts observed show clearly that the assimilating energy depends on the concentration of the pigment in the chlorophyll grains. The curve representing the assimilating energy may, according to the concentration of the pigment, rise to the upper limit of the natural radiation, as in ombrophobe plants, decrease before this limit, as in ombrophile plants, or may remain stationary, starting from a certain intensity, as in the yellow leaves of Taxus.—Spontaneous vegetation and the wholesomeness of drinking water: L. A. **Fabre**.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1905, contains the following memoirs communicated to the society:—

February 25.—A. **Sommerfeld**: The electron theory, iii.; on electrons with velocities equal to or greater than the velocity of light. H. **Happel**: On the equation of condition of monatomic substances.

May 20.—W. **Holtz**: How rotation can begin in a planetary nebula. W. **Holtz**: The reason for the star-shaped appearance of the stars. C. **Runge**: On the numerical solution of total differential equations.

June 3.—H. **Gerdien**: A new apparatus for the measurement of the electrical conductivity of the air. H. **Gerdien**: Measurements of the density of the vertical electrical conductive current in free air during the balloon ascent of May 11, 1905.

June 24.—Wilhelm **Blitz**: Contributions to the theory of "lakes" in dyeing.

The Business Notices, part i. for 1905, contains a report on the Samoa Observatory, a long obituary notice of Ernst Abbe by Prof. Voigt, and an appreciation of Georg Meissner by Prof. Max Verworn.

NEW SOUTH WALES.

Royal Society, August 2.—Mr. H. A. Lenehan, president, in the chair.—The refractive indices, with other data, of the oils of 118 species of Eucalyptus: H. G. **Smith**. In this paper the author records the refractive index, the specific gravity, the specific refractive energy, and the solubility in alcohol of the oil of each species. The material was distilled at the Technological Museum, Sydney, and most of it had been prepared for the work "Research on the Eucalypts and their Essential Oils," by Mr. R. T. Baker and himself. The oils of those species which have been obtained since that work was published are also included.

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THURSDAY, OCTOBER 12, 1905.

TWO RECENT VOLUMES ON ARACHNIDA.

On Two Orders of Arachnida. Opiliones, especially the Suborder Cyphophthalmi, and Ricinulei, namely, the Family Cryptostemmatoidae. By Dr. H. J. Hansen and Dr. W. Sörensen. Pp. 1–182; 9 plates. (Published by aid of a subsidy from the Royal Society of London, Cambridge, 1904.) Price 15*s.* net.

Palaeozoische Arachniden. By Prof. Dr. Anton Fritsch. Pp. 1–80; 5 plates and many text figures. (Prag: Selbstverlag. in comm. bei Fr. Řivnáč, 1904.)

ARACHNOLOGISTS must unite in a vote of thanks to Drs. Hansen and Sörensen for their splendid achievement in producing their treatise on Arachnida. The volume, announced many years ago as in preparation, is based upon a wealth of material borrowed from every available source such as no other taxonomists have been able to examine. It is a monument of careful research, and in every way worthy of the high reputation of its authors. Though written in a foreign tongue, the letterpress contains no passage of doubtful meaning; and Hansen's inimitable drawings have received full justice from the lithographic skill of Wilson at Cambridge. The Royal Society was well advised in contributing to the cost of publication.

The first and most valuable part of the book deals with the Opiliones, a highly specialised order the morphology of which has baffled previous workers. By the comparative and careful study of a host of forms, the Danish authors have succeeded in explaining the complicated structure of the genital area, or at all events in offering an explanation which will probably stand unless ultimately disproved by embryology. They have accepted the opinions of Simon and Thorell as to the division of the order into three suborders, and supplied diagnoses of the families of the Palpatores. In the case of the Cyphophthalmi, the least known of the suborders, a complete monograph of all the species is given, together with some new anatomical details, including the important discovery that the so-called ocular tubercles bear, not eyes, but the orifices of Krohn's glands. Incidentally, Stecker's monster, Gibbocellum, is disposed of, and, it is safe to say, will never again figure in literature.

The second part deals with an order of peculiar interest, the Ricinulei or Podogona, which has existed unchanged from Carboniferous to modern times. Amongst the anatomical discoveries made by Hansen and Sörensen, two stand out as of the greatest interest, namely, the presence of a pair of tracheal respiratory organs in the prosoma and of the elements of nine somites in the opisthosoma. The association of this order with the Pedipalpi, Araneæ, and Palpigradi is of interest, even if the reasons for it are unconvincing; but surely greater prominence should have been given to the fact that Börner anticipated the Danish authors in this matter!

Exact and admirable, however, as the work is, it must not be regarded as above criticism; nor must all the statements be accepted with a childlike faith. Far from it. The limitations of the authors are well known and are sufficiently in evidence in this volume, more especially in the pages dealing with the Micrura. For example, Börner's view that the "labia" in Arachnida are not homologous sclerites is worth far more than the unreasoned dismissal it receives; and it is not very obvious why the first abdominal sternal plate in the Ricinulei is homologised with the pregenital rather than with the genital sternite of the Pedipalpi. Exception also must be taken to the application of the term "antenna" to the appendages of the first pair, and of "mandibles" to the basal segment of those of the second pair, in the Arachnida. The first change is defensible only on the grounds that the cheliceræ of the Arachnida are the homologues of the antennæ of insects and of the antennæ of the first pair in crustaceans. Those who adopt this terminology, however, must consistently apply the term "antenna" to the buccal gnathites of Peripatus. Again, the name "mandible" is presumably given to the basal segment of the appendages of the second pair because of its supposed homological correspondence to the "mandible" of the insects or crustaceans—an opinion not generally accepted.

Points of this kind, however, would scarcely be worth mentioning were it not for the apparent inclination on the part of the authors to forget the possibility of two or more views being held on matters about which embryology is, up to the present, silent. As a last word of praise, may we, in all sincerity, congratulate the authors on the considerate tone of their criticisms and on the general absence of that air of self-satisfied arrogance for which certain Danish publications on Arthropoda have gained an unenviable notoriety? It is to be hoped that the English supervision of the letterpress is not in any way responsible for this improvement.

Dr. Fritsch's monograph of the Palæozoic Arachnida is a volume of a quite different character. Plainly speaking, it is an anachronism reminiscent of the dark days of palæontology when that science was held to be independent of neontology, or at all events independent in the sense that an acquaintance with the structure of the living species of a group was regarded as superfluous for the correct determination and description of its fossil forms. The comparative morphology of recent Arachnida, even with well-preserved material for examination, is difficult enough. Was it likely, then, that any great measure of success would attend the efforts to interpret the elusive structural points of Carboniferous fossils of a palæontologist unguided by scientific familiarity with recent forms? But, although want of the requisite knowledge is plainly attested and shatters all confidence in the alleged observations and attempted restorations, yet without examination of the specimens themselves no one has the right to affirm positively that a statement is false or a drawing inaccurate in any given particular. However strongly

one may suspect the contrary, there *may* have been a scorpion in Carboniferous times with the appendages segmented as shown in the figure of *Isobuthus kralupensis* (p. 71); or another with an additional sternal plate between the normal second and third of the opisthosoma, as in the restoration of *Microlabis sternbergi* (p. 69). Most of the specimens are in continental museums; but it so happens that there is in the British Museum a fossil scorpion which Fritsch figures and describes in the present work as *Eobuthus rakovnicensis*. To one acquainted with recent scorpions, it is obvious that this fossil resembles them in all essential points. Yet Fritsch's restoration represents an animal differing from all known forms in characters falling so wide of one's experience that it is impossible to estimate their systematic value. If this be taken as a test case, it supplies convincing proof of the untrustworthiness of the drawings and diagnoses in the book; for it shows that the author's anatomical knowledge is too superficial to enable him to distinguish between fortuitous fractures and intersegmental joints in the fossil examples.

Haase's classification of the Carboniferous Arachnida is followed tolerably closely. To the Araneæ (spiders), however, is added the new suborder Pleuraraneæ; but its genera seem to be nothing but Anthracomarti. Promygale, for instance, differs from Anthracomartus only in the alleged presence of abdominal appendages. The evidence, however, for the existence of these seems to be of the slenderest kind. In the Opiliones figures the new genus Dinopilio, which presumably should be classified under the Araneæ, perhaps near the Arthrolycosidæ.

The volume nevertheless contains some valuable work, in addition to its usefulness as a catalogue and bibliographical record. The discovery that in the Carboniferous scorpions the lateral eyes are in advance of the medians, as in recent species, disposes of Thorell's classification of these animals into Anthracoscorpii and Neoscorpii. The author is also to be congratulated upon showing that the structure from which Cyclophthalmus took its name is a half-circle, not of ocelli, but of granules.

It is impossible not to regret the necessity for giving an unfavourable notice of a volume which has cost its author much time and trouble; but since his high reputation as a palæontologist and the style of the illustrations are likely to deceive the uninitiated into regarding this treatise as an epoch-making monograph, it would be unfair to do otherwise than utter a note of warning against putting reliance in its contents to those not in a position to judge of its merits for themselves.

R. I. POCOCK.

THE CITIZEN AND THE STATE.

The Citizen, a Study of the Individual and the Government. By Nathaniel Southgate Shaler. Pp. viii+339. (London: A. Constable and Co., Ltd.; 1905.) Price 5*s*. net.

PROF. SHALER, who is professor of geology at Harvard, has set before himself the practical and unambitious task of instructing the youth of the United States in the first principles of citizenship. In this he has succeeded; his work is interesting, suggestive, and extremely sensible. Not being written for the specialist, it is hardly to be called profound; and the theoretical considerations which are brought forward are of the simplest. But the author's sound common sense generally carries the reader with it. A favourable specimen of his mode of argument may be found in the discussion of woman's suffrage. There is no reference to the various views held by thinkers from Plato downwards; but probably Prof. Shaler's one-page argument is quite sufficient, that women, owing to their usually secluded lives, are not fitted in the same way as men to form judgments on political questions, but that, after all, if a majority of women should desire to vote, it would probably be best to give them the franchise, for the reason that it is most undesirable to have any considerable body of the people in a discontented state.

Only a few of the topics discussed in this book can be referred to here. Prof. Shaler takes the moderate view that it is more profitable to the commonwealth to engage the interest of a hundred thousand well-informed men in politics than to have a hundred able statesmen created for public affairs. He depreciates the importance of oratory for the statesman in the present condition of American society, regards a sound head for business and a faculty for clear statement as much more valuable, and contends that the most successful statesmen in America are not (as in England) gentlemen of independent means, but lawyers and business men, whose training has taught them how to enter into associations with other men, to limit themselves to practical aims, and to form the schemes necessary for their realisation.

Naturally, in a work proceeding from the United States, one looks for, and finds, the glorification of the ideals and great men of that country; the contrast drawn between Washington and Napoleon; the contention that the War of Independence broke out because the American colonists had outgrown the system of the mother country; the distinction, too, which is drawn between the soldier and the citizen spirit. Prof. Shaler sees clearly, and discusses with impartiality, some of the most pressing difficulties of American politics. Not much is said about trusts and tariffs, and the currency is dealt with briefly. But immigration, foreign possessions, and the negro question are quite adequately treated. Prof. Shaler laments, of course, that the streams of immigrants no longer come from the most healthy strata of society in Europe; and, in addition to criminals, paupers, and other defective persons, he would exclude those who are not able to read and write in the English language or their own. He gives no support to the view that the mere profession of the doctrines of Anarchism should be followed by condign punishment. He sees no necessity for any attempt to extend the possessions of the United States beyond the sea. "Lynch law" he holds in detestation, and calls upon young America, on the occasions of any outbursts, however natural, of the lawless desire for vengeance, to put itself under the orders of the sheriff

and even to fire on the riotous crowd. As for the negroes, whom the United States have always with them, he suggests only the need for training in the simpler arts and handicrafts; for a literary education, in his judgment, they are still wholly unfit.

PRACTICAL ORGANIC CHEMISTRY.

A Systematic Course of Practical Organic Chemistry. By Lionel Guy Radcliffe, with the assistance of Frank Sturdy Sinnatt. Pp. xi+264. (London: Longmans, Green and Co., 1905.) Price 4*s.* 6*d.*

THIS book is intended mainly for students of elementary organic chemistry. The students are supposed to work about five hours per week, and, consequently, experiments which take a longer time, and must be finished without interruption, are omitted.

The exercises include a variety of important reactions and involve work with many of the more common compounds and reagents in organic chemistry. There is a set of exercises on the fatty compounds, and another on benzene; these include instructions in the observation of melting point and boiling point, in the determination of specific gravity, of the equivalent of an acid, and of sugar by the use of Fehling's solution.

This course worked through, there is a higher course, including the preparation of such substances as anisol, benzyl chloride, and benzaldehyde, the determination of equivalents and molecular weights, and of carbon, hydrogen, nitrogen, &c.

More care might have been spent on the finish of the book. The punctuation has been neglected; *e.g.* "recrystallise until the m.p.'s do not change" (p. 16), and "recrystallise the hydrobenzamide, formed from hot alcohol" (p. 110). The diction is not what it ought to be. "Heated alone succinic acid *sublimates*" (p. 196). "See if the *example* obtained [of methyl orange] is sensitive to acids" (p. 96).

The instructions for experiments are fairly detailed and generally good. Certain mistakes have been made. The student is repeatedly directed, after having dried a preparation by calcium chloride, to distil it in presence of the drying agent (*e.g.* pp. 54, 176). If a dry distillate is desired, the distillation should be carried out after removing the calcium chloride. Again, in determining molecular weight by Victor Meyer's method, the volume and temperature of the expelled gas may surely be read without waiting so long as an hour (p. 120). Is a minute not long enough?

Under protest, the authors give a section on the qualitative analysis of organic mixtures, "for the sake of students who are taking certain examinations." "The authors are quite sensible of the fact that the analysis of such mixtures cannot be regarded as useful practical organic chemistry" (p. 172). Surely this is an impatient verdict. Qualitative analysis is a valuable training in so far as the student is led to bring book knowledge to bear on work in the laboratory, and is prevented from taking suspicion for proof. The teacher should require him, in every case, to produce a specimen (or a derivative) of each constituent of the mixture. With this stipulation, knowledge, resource and judgment are needed in organic qualitative analysis even more than in inorganic. How many different ways are available for the separation of organic substances from one another:—precipitation, the use of different solvents, ordinary and steam distillation, extraction by ether from acid and alkaline solution, hydrolysis, oxidation, &c.! Surely time spent in mastering these methods of analysis is not wasted. A. N. M.

OUR BOOK SHELF.

Die Entwickelung der electrischen Messungen. By Dr. O. Frölich. Pp. xii+192; 124 illustrations. (Brunswick: Vieweg and Son, 1905.) Price 6 marks.

THIS is the fifth of a series of scientific monographs published under the general heading *Die Wissenschaft.* It consists of an historical sketch of the development of physical measurements, especially of those connected with electrotechnics. It must be admitted that in this go-ahead age the technical man finds little time to make a retrospect of his subject; he is too much concerned with its developed aspect. Even in colleges and schools, as the publisher states, the historical side of the subject is too much neglected. The present volume is intended to remove this reproach.

To give an idea of the book, we will outline here the first chapter (on current measurement). In its first section it deals with the first galvanometer, starting with the work of Oersted and Schweigger on the action of a current on a magnetic needle. Then follow the fundamental laws of constant currents as developed by Ohm, Ampère, Biot-Savart, and the methods of demonstrating them. The astatic needles of Nobili and Davy and the measurements of Faraday are next described, and this section concludes with the methods devised for calibrating the early types of galvanometer.

The second section is called the mirror galvanometer. It describes the work of Gauss and Weber on absolute measurements, the first telegraph of Gauss and Weber (1833), and the Atlantic cable furnished with mirror galvanometers by Lord Kelvin (1858). The remainder of the section deals with improvements effected in the control of the moving system (damping, &c.), and describes the galvanometers of Wiedemann, Siemens, and Kelvin, and the more recent variants of du Bois and Rubens, Paschen, Hartman and Braun, d'Arsonval, Edelmann, and Siemens and Halske.

When it is mentioned that all this is included in thirty pages it will be realised that the descriptions are exceedingly brief. The general impression conveyed is that for a book of this kind to be of much use, fuller treatment is necessary. Still, it will serve to direct attention to the general trend of advance, and to indicate the names of those that share the chief honour of it. Its value would be considerably increased by a larger number of references to original sources of information. These are given sometimes only.

Zoologischer Jahresbericht für 1904. Edited by Prof. P. Mayer. (Berlin: Friedländer and Son, 1905.)

THE zoological station at Naples, for which this bulky volume, like its predecessors, is published, is to be congratulated on the early date of its issue and the thoroughness with which the various contributors

have done their work. In issuing a register of zoological work for 1904 so early as September of the present year, the editor and publisher have indeed beaten our own "Zoological Record"; but it must be remembered that in the present volume is included a considerable amount of literature belonging to earlier years, while it is difficult to believe that the whole of the papers for 1904 can be included.

It might be imagined, for those not conversant with the two works, that the "Zoologischer Jahresbericht" is a serious rival to the "Zoological Record," and that the publication of the one renders that of the other superfluous. As a matter of fact, this is not the case; for, in the first place, it is highly desirable that a record of zoological literature should be published in English, and, in the second, the two publications do not cover the same ground. The "Zoological Record," for instance, is specially devoted to the systematic aspect of the subject, particular pains being taken to include the names of all new species and subspecies. In the Continental work, on the other hand, systematic work is rigorously excluded, and attention concentrated on the bionomical, anatomical, and physiological aspects of the subject. The two records are therefore to a considerable extent supplemental and complementary to one another, more especially as in the one before us a somewhat full *précis* of the main subjects of the more important papers forms an important feature. The practice of including all the papers on Vertebrata under a single heading does not, indeed, appeal to us; but then, it is true, this is in some degree compensated by dividing the summary of their contents into their respective class-positions. So far as we have been able to judge, the quotations of the titles of the papers and the references to their places of publication are singularly free from error, and the volume, like its predecessors, cannot fail to be of the highest value to all workers in morphological and anatomical zoology.

R. L.

Examples in Arithmetic. By C. O. Tuckey. Pp. xii+241+xxxix. (London: George Bell and Sons, 1905.) Price 3*s*.

The Primary Arithmetic. Parts i. and ii. Edited by Dr. Wm. Briggs. Pp. 80 and 94. (London: The University Tutorial Press.) Price 6*d*. each.

THESE books are intended for the use of teachers who instruct their classes orally in the processes and rules of arithmetic, and who only require the assistance of graduated sets of exercises. In the work by Mr. Tuckey the course is fairly complete, embracing the usual commercial arithmetic, with a chapter on the application of proportion to problems in geometry and physics, and a section devoted to numerical computations by the aid of compound interest, logarithmic and trigonometrical tables, in which a little elementary trigonometry is introduced. There are examples on graphs and squared paper work, and the users of the book will have an abundant choice of exercises of modern type.

"The Primary Arithmetic" will be complete in three parts. The first part gives sets of exercises on the four simple rules and on the compound rules for money. The examples increase in difficulty by almost imperceptible stages, beginning with those of the simplest kind, and they are suitable for very young scholars. Part ii. completes the compound rules for weights and measures, including the metric system. Then follow exercises on vulgar fractions and on practice and invoices. In these two parts, as well as in the book by Mr. Tuckey, the answers to the exercises occupy a considerable space at the end of each volume.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

A Magnetic Survey of Japan.

IN NATURE of April 20 (vol. lxxi. p. 578), Prof. A. Schuster has given a comprehensive review of the magnetic survey of Japan with a friendly criticism. The responsibility of its writer may be a sufficient excuse for the following remarks partly in way of reply.

Prof. Schuster directs attention to the small space given to the description of the working of the instruments. This arises from the fact that these instruments were essentially the same as the one used in the previous survey of 1887, and described in vol. ii., pp. 178–193, of the *Journal of the College of Science*, Imperial University, Tokyo, to which the reader is referred for details. A few improvements that have since been made are mentioned in the present report, pp. 7–8.

We are glad to see that the methods adopted for calculating the corrections for heights of stations and the way of disposing with the vertical current met his approval; only Prof. Schuster seems to attribute these currents to uncertainties in the observations, whereas we infer that they are as much, if not more, due to the inadequacy of the empirical formulæ, from the fact that they vanish near the middle of the several countries treated (p. 125).

Perhaps the more important point is with regard to the question of the seat of action. To avoid confusion, it might be well to remark that the word potential is used in different senses by different writers; some use it to denote a function which satisfies the Laplacian equation $\nabla^2V=0$, and others to denote the line integral of any irrotationally distributed vector, whether the solenoidal condition be satisfied or not. It is in the latter general sense that the word is used in the report.

Now Gauss's method of separating internal and external sources of action is based upon the assumption that these sources are entirely separated from each other by a free space; in other words, the Laplacian equation holds strictly over a finite portion of the space surrounding the earth surface. This is very plausible when we consider the earth as a magnetised body, as appears *a posteriori*. But when we abandon the restriction of the solenoidal distribution the method is no more applicable, and the observation of force over a spherical surface is not sufficient to settle the seat of action, although it may be expansible in harmonic form if its distribution is continuous, so that the Gaussian expansion must be taken in "Gauss's sense" (end of first paragraph, p. 140 of the report).

The possibility of the distribution of magnetism in the space surrounding the earth surface might appear quite extravagant, and may be included amongst what Gauss calls "boldenlose Phantasien," so long as we are considering the main causes of the terrestrial magnetism; but when we come to discuss the external causes and the horizontal atmospheric current the effects of which amount to only a small fraction of the observed forces, our assumption of the distribution being thoroughly solenoidal would seem subject to doubt, or at least to require observational evidence, so that "strictly speaking, the mode of distribution must remain perfectly arbitrary so long as we adhere solely to the observed elements" of magnetic forces on a spherical surface, when no further assumption than the Newtonian law of action is admitted.

It may not be unnecessary to add here that the search for the seat of action from observations of force over a surface is an inverse problem, and includes any arbitrary distribution of magnetism the resultant effect of which vanishes on that particular surface; we can put any system of magnets or electric circuits outside the surface, provided we envelop that surface with a counteracting shell or shells over which a proper distribution of magnetism is made according to Green's method of finding the density of induced electricity on a conductor, besides any

amount of closed magnetic shells and solenoids. It will thus be seen that even if we take the internal and external sources to be detached, the plain proposition given by Prof. Schuster would appear to require a modifying clause in order to be exact. A. TANAKADATE.

Physical Laboratory, Imperial University, Tokyo, August.

A Polarisation Pattern.

THE following may be of interest to some of your readers. A cylindrical mica chimney of an Auer gas-light is placed vertically on a varnished table. If we look through it at the diffused daylight from a window reflected by the table, faint coloured bands are seen running parallel to the length of the cylinder near both edges. If observed through a Nicol's prism, the band appears very beautiful. T. TERADA.

Physical Laboratory, Science College, Imperial University, Tokyo, September 8.

A Focusing Screen for Use in Photographing Ultra-violet Spectra.

THE sensitive surface upon which Stokes projected the ultra-violet rays when observing metallic lines and absorption spectra consisted of a plate of plaster of Paris moistened with a paste of uranium phosphate acidified with phosphoric acid (*Journ. Chem. Soc.*, vol. xvii., 1864). Soret used uranium glass and solutions of fluorescent substances such as æsculine in liquid cells. I have found that the most convenient and effective screen for examining spectra with a quartz spectrograph is one such as is used for the X-rays. It may be made as follows:—a photographic plate is first cleared of silver bromide by fixing and washing, and when the film is partly dry, but the gelatin still soft, it is dusted over with a powder of barium platinocyanide crystals, so as to be somewhat thickly coated with the salt. This is fixed in the dark slide of the camera. To focus a spectrum, the slide is tilted to the necessary angle, and a somewhat powerful focusing glass with a flat field is applied to the uncoated surface of the plate, when both the visible and ultra-violet spark spectra may be plainly seen by transmission, the latter by reason of the fluorescence excited. The focusing glass should be first carefully adjusted for any visible object on the other side of a plain glass plate, such as a fine hair fastened upon it, and the position of the eye-piece is then fixed. Suitable focusing glasses are those made by Dallmeyer and by Taylor, Taylor, and Hobson. When the spectrograph has been adjusted by means of the screen, the ultra-violet lines appear quite as sharp as those in the red and yellow, even the details in the group of cadmium lines between wave-lengths 2100 and 2400 are well defined, and a very fair photograph may be obtained; but for the most accurate focusing photography must be resorted to. W. N. HARTLEY.

Royal College of Science, Dublin, October 2.

The Omission of Titles of Addresses on Scientific Subjects.

THE published reports of the British Association make an omission of an equal and opposite character to that about which your correspondent complains. Perhaps these are intended to cancel out. I refer to the publication of titles only, without any text. On receiving the last report (1904, Cambridge) I analysed this matter so far as it relates to Sections A and G, in which I am most interested. In Section A there were 83 communications, 29 of which appear by title only, and of these publication elsewhere is referred to in foot-notes in 4 cases, leaving 25 to the recollection of the audiences who heard them. Section G was better. There were 25 communications, and 13 appeared by title only; but of these 9 may be traced by those who take the trouble to consult the other publications referred to in the foot-notes. A. P. TROTTER.

Westminster, October 3.

THE INTERNATIONAL CONGRESS ON TUBERCULOSIS.

THE International Congress on Tuberculosis, held in Paris on October 2–7, has undoubtedly served as a medium for a most fruitful interchange of views by those interested in the struggle against tuberculosis. The congress was held in the Grand Palais, which from its extent enabled the members to be collected under one roof. The first day was devoted to the formal opening, when the delegates were welcomed by the President of the French Republic, who also after the close of the congress gave a reception at the Palais de l'Elysée. The chief social functions, which were characterised by complete success, comprised a reception at the Hôtel de Ville by the Municipality of Paris, an "at home" by the *Figaro*, at which performances were given by well known artistes, a soirée at the Hôtel Continental given by the president of the congress, Dr. Hérard, another at the Châtelet Theatre by the *Matin*, and a visit to Vaux de Cernay on the invitation of Dr. Henry de Rothschild.

The British Government was represented by Dr. Theodore Williams and Dr. Bulstrode, the National Association for the Prevention of Consumption by Sir William Broadbent and Dr. Perkins, while the foreign Governments and all the leading medical societies and institutions had their special official representatives.

The chief feature of the congress was reserved for the closing *séance*, when Prof. v. Behring announced that he had every reason to hope he had discovered a method of treating tuberculosis which would be as efficacious as the anti-toxin treatment of diphtheria he had first proposed in 1890.

His statement, received with great enthusiasm, was to the effect that, although he had made a great step, the value of his proposed procedure must be tested on animals in other laboratories than his own, and clinically by physicians with an intimate knowledge of the varieties of pulmonary tuberculosis, before it could be said that an actual curative medium had been found.

Prof. Behring, as had been anticipated, gave no exact details as to the method of obtaining or administering his latest therapeutic discovery, but the earlier stages of his work are to be explained in a forthcoming book entitled "Modern Problems of Phthisiogenetic and Phthisiotherapeutic Physiology illuminated by History."

His experiments have led him definitely to abandon the idea of introducing living tubercle bacilli into the human body with a therapeutic object. He has discovered a substance, to which he has given the name T.C., which represents the vital principles of the tubercle bacillus of Koch. To the presence of this substance, which possesses extraordinary fermentative and catalytic properties, is due both the hypersensibility of living organisms to Koch's tuberculin and the protective reaction against tuberculosis. This T.C. impregnates and becomes an integral part of the cells of any organism with which it comes in contact, undergoing a metamorphosis into another substance to which the name T.X. has been given.

This elaboration of T.C. in the organism is a long and perilous process. Prof. v. Behring claims to have succeeded in producing this change *in vitro* by freeing the T.C. from certain substances which impair its therapeutic action. Of these he distinguishes three groups:—(1) a substance (T.V.) only soluble in pure water, and possessing a fermentative and catalytic action. To the presence of this substance are due the toxic effects of Koch's tuberculin. One gram of this in the dry state is more toxic than a litre of the old

tuberculin. (2) A globulin (T.G.L.), soluble in neutral saline solutions, and also toxic. (3) Several non-toxic substances soluble only in ether, chloroform, and the like. The residue of the tubercle bacillus after the removal of the foregoing he terms the restbacillus; this still retains the form and staining reactions of the original tubercle bacillus. The restbacillus can be converted into an amorphous substance readily taken up by the lymphatic cells of animals undergoing a metamorphosis and leading coincidently to the production of oxyphil granules in these cells and of immunity to the tubercle bacillus in the organism as a whole.

Prof. v. Behring has convinced himself that this T.C. can be elaborated *in vitro* in a fashion which will enable it to be applied efficaciously and without danger in human therapeutics, but until this has been confirmed he does not propose to publish his full results.

The scientific interest of the congress naturally divided itself into two parts, the exhibition of pathological specimens, of models, photographs, and plans of sanatoria, instruments, sterilising machinery, and the like in the museum on the ground floor of the Grand Palais, and the actual communications made to the congress. Both presented features of great importance. Among the exhibits of more especial interest were a series of specimens indicating the results of inoculation of bovine, human, and avian tubercle in different animals, lent by the Gesundheitsamt of Berlin, and a similar series shown and thoroughly demonstrated by Dr. Lydia Rabinowitsch. The latter observer had been able to show the varying grades of virulence of the tubercle bacilli from different sources, but had not been able by transference through different animals to convert bacilli with the cultural properties of bovine bacilli into those with the cultural characters of human tubercle bacilli and *vice versâ*, although this could not be seen from the naked-eye appearance of many of the specimens. Neither had she so far repeated Nocard's results of converting avian into human or human into avian bacilli, although she exhibited an example of a bird which had suffered, apparently spontaneously, from tuberculosis, in which the cultural appearances were those of human bacilli. Dr. Calmette, of the Pasteur Institute of Lille, showed an important series of specimens from goats and kids. Kids which had been fed on the milk from mothers the mammæ of which were infected with bovine tubercle presented caseation of the mesenteric glands and also pulmonary lesions, apparently spreading through the peribronchial glands and lymphatic chain, although the retropharyngeal chain of glands remained uninfected. In cases in which the mothers had been inoculated with human or avian tuberculosis or with the Timothy bacillus only the mesenteric glands were infected. Adult goats to which doses of a culture of bovine tubercle had been administered through an œsophageal tube always died rapidly of *pulmonary tuberculosis* without apparent intestinal lesions and only a few scattered points of caseation in the mesenteric glands. Nothing approaching the degree of mesenteric affection seen in kids was found. This confirms Prof. v. Behring's announcement in 1903 that pulmonary tuberculosis might result from intestinal infection without producing local lesions at the point of entry. The Alfort Veterinary College showed a series of specimens, and others were to be seen in the museum of the college, which members of the congress were invited to visit. Amongst others were examples of the comparatively rare tuberculosis of the horse, and evidences that dogs suffer severely both from pulmonary and intestinal tuberculosis. Prof. G. Petit, of Alfort, has shown that such affections are steadily on the increase, and constitute an important factor in the campaign against tuberculosis, since a household otherwise protected to the best of human ability may become infected by a pet dog, which, having acquired tuberculosis in the streets or elsewhere, subsequently lies on the bed of children and licks their faces. The tuberculosis of dogs is more often open than had been anticipated; this means that tubercle bacilli would be constantly about their mouths, and so be readily transferred. The most common organism is the human bacillus, and the dogs most affected are those from small cafés where the air is constantly full of dust and dried sputum.

In the hygienic section were full size models showing the ordinary hotel room with its heavy hangings and dust accumulation, and the same room as it should, and could at less cost, be properly furnished with easily disinfected materials. Another group showed the great superiority in light, air, and general hygiene of a prison cell over the attic rooms with skylights, often not opening, in which most servants in Paris are accustomed to sleep.

For the purpose of receiving communications the congress was divided into four sections, the first two dealing with medical and surgical pathology and therapeutics respectively, the third with the protection of infant life, and the fourth with the protection of the adult and social hygiene.

In many subjects the two former sections overlapped, especially in dealing with the nature and varieties of tuberculosis and the value of serotherapeutics. The general conclusions appeared to be that the morphological appearances of the different varieties of the tubercle bacillus and other acid-fast bacilli were very similar, but that cultural differences existed, and that there were wide variations in toxicity. Special reports were made on this subject by Profs. Arloing, Kossel, and Ravenel. These showed that the infection of man by bovine tubercle bacilli, which are the most virulent, could occur through feeding with the unsterilised milk of tuberculous cows. All mammals appeared to suffer from infection by both types of bacilli, but no other type of mammalian bacilli could be established from cultural or morphological characters. So far as was known, tubercle bacilli modified in virulence by passing through animals other than mammals could be ultimately traced to a human or bovine origin, and restored by passage through cultures and other animals to their original forms. While the general impression seemed to be that the tubercle bacillus is in reality but one species, it was admitted that no evidence of transformation of the one type into the other, in cultural characters at any rate, had so far been produced, although varying grades of virulence in each type were recognised.

In a general study of acid-fast bacilli, Drs. Besançon and Philibert distinguish between true acid-fast bacilli which remain so under all conditions of culture, growth, and passage through animals, and those which for a single generation have acquired acid-fast characters.

They found that many bacilli grown on appropriate media containing fats, of which lanoline was the best, acquire the power for some time of resisting decolorisation by acids or by acids and alcohol. Subcultures grown on similar fatty media are also acid-fast, but subcultures on ordinary media possess no such power. To distinguish between these groups it was necessary to stain for a longer period than usual, and then to expose the films to the action of acid for many hours.

When deeply stained the tubercle bacillus will resist decolorisation for twelve to eighteen hours; the

pseudo-acid-fast bacilli resist for much shorter periods.

During the discussions on serotherapy it was stated that good results had been obtained by treatment with filtered broth cultures of tubercle bacilli as employed by Prof. Denis, of Louvain, with a new variety of tuberculin extracted from tubercle bacilli by means of a 1 per cent. solution of orthophosphoric acid introduced by Dr. Beraneck, of Neuchatel, and with the anti-toxic serum invented by Dr. Marmorek. The latter observer had made a medium of leuco-toxic serum, obtained by injecting goats with leucocytes of other animals, and spleen bouillon, and inoculated this from the very edge of young cultures of tubercle bacilli. These showed a rapid growth, and the products of their growth in this medium were injected into horses in repeated small doses; when these horses had been sufficiently immunised their blood was used as a source for the serum. This serum had given its best results in cases of surgical tuberculosis, *i.e.* diseases of joints and the like, but the effects in pulmonary tuberculosis were held to be such as to justify a more extended trial being given to this method.

In the subsection on therapeutics various methods of treatment were put forward, amongst others the intravenous injection of iodoform in suspension in a mixture of ether and liquid paraffin which had been tried with some success by Dr. Dewar, of Dunblane.

Several communications were made on the respiratory changes in the subjects of pulmonary tuberculosis, the general conclusion being that they in no wise differed from those in normal or slightly febrile individuals. A series of reports was made on the early diagnosis of pulmonary tuberculosis by radiography, cytoscopy, blood counts, and other methods. Dr. Theodore Williams pointed out that the time had not yet come for supplanting the ordinary methods of auscultation and percussion, an opinion strongly agreed to by Prof. Grancher and Dr. Turban, of Davos.

In the third section abundant evidence was given of the necessity of proper care being taken of children, especially to avoid infection, great stress being laid on the danger of their occupying the same room as a subject of pulmonary tuberculosis, and the absolute necessity for a properly supervised milk supply. In a general resolution of the congress it was decided to recommend the periodical Government inspection of all dairies, and that no public institution should make use of milk that had not either come from cows which had passed the tuberculin test or had been Pasteurised or boiled.

In the fourth section Dr. Newsholme directed attention to the diminution in the death rate from pulmonary tuberculosis which had followed the replacement of domestic by institutional relief.

A discussion on the relative merits of sanatorium and dispensary treatment resulted in the conclusion that each had its place, and that the educational factor must not be forgotten, since the diminution of tuberculosis depended more on prophylaxis than on individual treatment. The advantages of the French dispensaries over the out-patient departments of most English hospitals were that since one or more of these are situated in each district of Paris and other cities, patients have not far to come, and domiciliary visits could be made to encourage the carrying out of any precautions recommended. Owing to the distance from which patients come this was at present quite impossible to organise for London hospitals. Such a system had, however, been organised in connection with the dispensary attached to the Victoria Hospital in Edinburgh, and had been productive of most excellent results. It was in matters connected with hygiene and social factors generally that the most good resulted from the London congress, and it is to be hoped still more will follow the narration of the experience gained since that time. The real hope for the community as a whole would appear to lie in the protection of the individual, and more especially of the child, if Prof. Behring's views on latency and intestinal infection hold good, from infection rather than in the treatment of those already tuberculous, since even if treatment restore the latter to some degree of working capacity, and the average sanatorium result is put at five to seven years' prolongation of active life, they but serve as foci for fresh infection.

In addition to the actual scientific papers brought forward, perhaps the greatest and best work of the congress consisted in the private interchange of views between workers of different nationalities, and in the visits to various institutions, sanatoria, and hospitals in and around Paris.

The Pasteur Institute, the veterinary college at Alfort, the Boucicaut Hospital and the sanatoria at Bligny, Angicourt, and Ormesson were among those inspected by the greatest numbers.

At the concluding *séance* it was announced that the next congress would be held in America in three years' time.

THE BRITISH ASSOCIATION IN SOUTH AFRICA.

THE association party left Maritzburg early on Saturday morning, August 26, and proceeded through the upland districts to Colenso, where a halt of special interest had been arranged. Arriving at that now historic centre with some hours of daylight to spare, a visit was paid to the site of several battles and engagements connected with the attempts to relieve Ladysmith.

The next morning, August 27, the trains slowly steamed through one of the passes leading into Ladysmith, where evidence of the severity of the struggle of a few years ago was seen on every side in groups of graves and monuments. Ladysmith was left in the evening, and Majuba and Laing's Nek, with the scenes of struggles in the late war in northern Natal, were passed in the darkness. Daylight revealed Standerton in the Transvaal at hand, and Johannesburg was reached amid exclamations of wonder at the gigantic heaps of tailings from the gold workings which were passed during the last few miles of the journey.

Of the work done in Johannesburg in connection with the sections little need be said here, but the attendances were certainly remarkably good, and the discussions revealed a high average of capacity to discuss the various problems which were presented by the papers read. Prof. Darwin's own words at the close were felt to be fully deserved when he observed, in bringing the formal work to a close, that the meeting of the association in Cape Town and Johannesburg constituted one of the most remarkable and one of the most successful of the long series held in various centres in Great Britain, Ireland, and the colonies.

The more social functions connected with the visit to Johannesburg must be described as brilliant successes. These commenced with a reception by the mayor and town council at a conversazione held at the Wanderers' Club. His Excellency the High Commissioner, Lord Selborne, was present, and graciously received many of the more distinguished of the visitors and those who had been most prominent in preparing for the visit of the association in the different South African centres.

On the following days visits were paid to various mines, both to the underground and surface workings, and to the native and Chinese compounds; and courteous guides explained the various gold extraction processes. At one of the mines some thousands of natives delighted the visitors with a Kafir dance to the accompaniment of music on native pianos and drums.

A lecture by Prof. Ayrton on "The Distribution of Power," which had involved some weeks of preparation of elaborate machinery, was greatly appreciated, though many heard with wonder of his disparagement of the Victoria Falls as possible sources of power in the future.

A garden party at Sunnyside to which an invitation was given by Lord Selborne was very largely attended. Perhaps the great event of the Johannesburg visit was the occasion of Prof. Darwin's presidential address, which consisted of a *résumé* of the main features of the Cape Town section and the delivery of the second half of his official paper.

Opportunity was taken by Lord Selborne and Mr. George Goch, the Mayor of Johannesburg, to tender official welcomes to the association, to which the president replied in one of the graceful and fitting addresses which have constituted so noteworthy a feature of the visit.

Thursday, August 31, was taken up with a visit to Pretoria as the main attraction, with the addition of visits to the Modderfontein Dynamite Factory and the Premier Diamond Mine.

At Pretoria the whole party was entertained at luncheon at some of the principal hotels, and in the afternoon Sir Arthur Lawley, Lieutenant-Governor of the Transvaal, held a reception at the museum. The president and some of the visitors stayed overnight in Pretoria, where Mr. A. E. Shipley gave a lecture on "Fly-borne Diseases." The same evening Prof. J. O. Arnold lectured in Johannesburg on "Steel as an Igneous Rock."

During the concluding day of the Johannesburg visit, the general committee meeting and the annual meeting of members were held, when Dr. Ray Lankester was elected president of the association for the ensuing year, and the officers and council were re-elected with slight changes only in the *personnel* of the latter.

As many of the papers read at the various sections had proved of deep South African interest, it was heard with pleasure that local arrangements were being made to publish the same in a separate volume subject to the consent of the authors being obtained.

From Johannesburg and Pretoria several treks of special interest to geologists and others were arranged, and among these were journeys across country to Mafeking, which necessitated omitting the visits to Bloemfontein and Kimberley, but evidently resulted in compensation of quite another kind to those who braved the inconveniences and hardships of the journey.

Prior to leaving Johannesburg Prof. Darwin announced that some of his fellow-members desired to establish a permanent link between the association and South Africa, and it had been proposed that a subscription should be raised for a medal to be given annually to a South African student in commemoration of the visit of the British Association.

The journey to Bloemfontein did not afford much opportunity of seeing the country until early morning, when several scenes of war interest were passed. The arrival in Bloemfontein on Saturday, September 2, was followed by a public welcome by the mayor and town councillors and the local Philosophical Society in the Town Hall. The function was numerously attended, and the addresses were given and received with equal cordiality. During the morning the various public buildings were visited, and in the afternoon a reception and garden party were held.

In the absence through illness of Sir H. J. Goold-Adams, the Lieutenant-Governor, his place was taken by the Acting Chief Justice, Mr. Justice Fawkes, and Mrs. Fawkes, who graciously received the visitors. The trees and bush of the grounds afforded welcome shade, and all the accessories of the occasion were such as conduced to the comfort and pleasure of all present. In the evening Mr. A. R. Hinks lectured on "The Milky Way and the Clouds of Magellan."

On September 3 a visit was paid by train to the Government Experimental Farm at Tweespruit, a halt being made *en route* at Sannah's Post with its lamentable memories. In the course of the day a trek party left for Kimberley by way of Abraham's Kraal and Paardeberg, the scene of General Cronje's capture.

On the morning of Monday, September 4, the main party left by train and proceeded by Nowal's Pont, Naauwpoort and De Aar to Kimberley, which was reached early the next morning. The programme of entertainments for the next two days was very full. Naturally the diamond mines were the centres of greatest interest, and ample provision had been made for visits underground, to the pulsator, compounds, and surface works generally. Parties were made up of numbers sufficiently limited to admit of adequate explanation of the various processes being given, an arrangement which was much approved.

On the afternoon of the first day, September 5, the mayor and mayoress, Mr. J. D. and Mrs. Tyson, held a garden party in the Public Gardens, which afforded a much coveted opportunity for introductions of citizens to visitors. In the evening Sir Wm. Crookes gave his lecture on "Diamonds" in the Town Hall. Elaborate preparations had been made for the interesting experiments by which the lecture was illustrated, and these passed off most successfully. So numerous were the applications to attend the lecture that Sir William kindly repeated it the following afternoon.

On Wednesday morning, September 6, most of the visitors were taken by special train to the Du Toit's Pan and Wesselton mines, and the compound life of the natives was more minutely examined. The open workings at Wesselton enabled a more perfect idea to be formed of the methods which obtained in the older mines at the beginning of operations. During the day Alexandersfontein and Kenilworth attracted many visitors, and in the evening Prof. J. B. Porter, of McGill University, gave a lecture entitled "The Bearing of Engineering on Mining."

At mid-day on Thursday, September 7, the special trains for Bulawayo commenced to leave, and a journey which lasted until Saturday morning, September 9, introduced the travellers to many interesting scenes, many of which were of a type entirely different from any hitherto experienced. The richly wooded districts of British Bechuanaland called for frequent use of the camera, and not a few curios were purchased from the natives.

On arrival at Bulawayo, where the accommodation was limited, many of the party had to sleep in the train, a proceeding which, however, was hardly regarded as an inconvenience.

The library, which had been turned into a reception room for the occasion, brought a numerous company together, and the post-office counter was thronged for a considerable period owing to the great demand for the new Victoria Falls stamps just issued in

different values. The revenue had no small gains from the sales, hundreds of sets being bought up and cancelled without being used.

In the course of the morning of September 9 Prof. Darwin opened the recently acquired museum, which on being entered was found to contain a local collection of great scientific interest. Many of the visitors expressed their regret that time was not available for a more minute study than was possible on this occasion. The afternoon was taken up by a visit to Government House, the site of Lobengula's kraal, where, in the absence of the Administrator, a reception was held by the Treasurer, Mr. Newton. Lobengula's tree of justice was a centre which all sought.

In the evening Mr. D. Randall MacIver gave a lecture-report on the "Rhodesian Ruins" which attracted a numerous audience, it having been whispered abroad that his conclusions ran counter to the theories of great antiquity which have hitherto generally held the field. Mr. MacIver's address was lengthy, and dealt chiefly with one class of evidence. Although the last word has not been said upon the subject, Mr. MacIver has certainly thrown new light upon it.

The Matopos and World's View, with the tomb of Cecil Rhodes and the Shangani monument, which called for two special trains to convey the visitors, seem to have surpassed all preconceptions, and the magnificence of the surrounding views and the quiet dignity of the last resting-place of Rhodes seem to have created the same feeling in the breast of nearly everyone present, a desire to contemplate the whole scene in the silence and solitude impossible on such an occasion. A brief religious service was conducted by the Rev. Mr. Bevan at the side of the tomb.

On Monday morning, September 11, five special trains left for Victoria Falls, and the journey through the teak forests seemed a fitting prelude to the solemn grandeur of the scenes to be viewed on the morrow.

Only some thirty hours were allotted to the falls visit, but such were the arrangements made by Sir Charles Metcalfe that the main features, both of the falls, the ravine below, and the river above, could be compassed by the energetic sightseer in the time.

The first business of the day was the opening of the new bridge by Prof. Darwin, after which Palm Kloof, Livingstone Island, the Rain Forest, and many other points of vantage and interest were visited. Not a few also enjoyed a moonlight visit to the falls, the moon fortunately being full. The next morning canoes were requisitioned for trips up the lovely island-dotted river, and the "hippos" were obliging enough to put in an appearance for the occasion. Soon after noon the special trains commenced the return trip to Bulawayo, the first stage on the journey home.

At Bulawayo the trip, which, save for a few special excursions, had been of a homogeneous character, was brought to an end. The party was here divided into two sections, the one preferring the voyage home by way of Cape Town, the other *viâ* Beira and the east coast. The latter route proved to possess the greater attractiveness, judging by the numbers who elected to return that way, which was not surprising when an opportunity of making the round journey in such circumstances was considered.

Of the visit as a whole it only remains to add that it has been a success beyond the most sanguine dreams of its promoters. The hospitality throughout has been generous to the extent of lavishness, the labour of the various local committees has been as wisely exercised as it has been unremittingly pursued, and the only regret seems to have been that the time allotted to each town was necessarily so short.

That the true interests of science both in the mother country and in the colonies have been advanced by this unique meeting of the association cannot be doubted, and the results will continue to be seen in many directions after many days.

THE BRITISH SCIENCE GUILD.

The inaugural meeting of the British Science Guild will be held at the Mansion House on Monday, October 30; and the Lord Mayor, who has consented to preside, will take the chair at 4.15 p.m. The guild appeals to the people of Britain within and beyond the seas, and its chief object is to bring home to all classes the necessity of making the scientific spirit a national characteristic which shall inspire progress and determine the policy in affairs of all kinds. The organisation is associated with no political party, and its membership is open to all British subjects, whether men or women.

At the inaugural meeting of the guild, on October 30, the following officers will be proposed:—

President: the Right Hon. R. B. Haldane, K.C., M.P.; vice-presidents: the Right Hon. the Lord Mayor of London, Sir Lawrence Alma-Tadema, R.A., O.M., the Right Hon. Lord Balcarres, M.P., the Right Hon. the Earl of Berkeley, Sir William Broadbent, Bart., K.C.V.O., F.R.S., Sir Walter Buller, K.C.M.G., F.R.S., Sir J. Burdon-Sanderson, Bart., F.R.S., Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Sir William Church, Bart., Sir George Sydenham Clarke, K.C.M.G., F.R.S., Sir John Colomb, K.C.M.G., M.P., the Right Hon. the Earl of Donoughmore, the Right Hon. Earl Egerton of Tatton, Sir John Eliot, K.C.I.E., F.R.S., Sir Michael Foster, K.C.B., O.M., M.P., F.R.S., the Right Hon. Sir Edward Fry, F.R.S., Sir Archibald Geikie, F.R.S., Mr. F. Du Cane Godman, F.R.S., the Right Hon. Sir John Gorst, K.C., M.P., F.R.S., the Right Hon. Lord Haliburton, G.C.B., Sir Joseph Hooker, G.C.S.I., F.R.S., the Right Hon. Viscount Knutsford, G.C.M.G., Prof. Ray Lankester, F.R.S., Dr. J. Larmor, F.R.S., the Right Hon. Lord Lister, F.R.S., Sir Charles McLaren, Bart., K.C., M.P., the Right Hon. Sir Horace Plunkett, K.C.V.O., F.R.S., Mr. E. Robertson, K.C., M.P., the Right Hon. Lord Tennyson, P.C., G.C.M.G., His Grace the Duke of Wellington, K.G., G.C.V.O.; chairman of committees: Sir Norman Lockyer, K.C.B., F.R.S.; vice-chairmen: Sir William Abney, K.C.B., F.R.S., Sir Lauder Brunton, F.R.S., the Hon. Sir John Cockburn, K.C.M.G., Sir Gilbert Parker, M.P.; trustees: the Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., Sir Henry Roscoe, F.R.S.; hon. treasurer: the Right Hon. Lord Avebury, F.R.S.; hon. assist. treasurer: Lady Lockyer, 16 Penywern Road, S.W.; hon secretary: Mr. C. Cuthbertson.

A large general committee, which will include the names of the present organising committee, will also be proposed for election.

Since the first meeting, held at the rooms of the Royal Society in April, 1904, the labours of the organising committee have been directed to securing the help of representatives of all sides of the nation's activities to secure the objects of the guild, which are

(1) To bring together as members of the guild all those throughout the Empire interested in science and scientific method, in order, by joint action, to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavour, and thus to further the progress and increase the welfare of the Empire.

(2) To bring before the Government the scientific aspects of all matters affecting the national welfare.

(3) To promote and extend the application of scientific principles to industrial and general purposes.

(4) To promote scientific education by encouraging the support of universities and other institutions where the bounds of science are extended, or where new applications of science are devised.

During the first stage of the existence of the guild, the public activity of the committee was limited, by reasons of policy, because at the moment of the inception of the movement the attention of the country, and especially of Parliament, was so deeply engrossed in the fiscal problem that no other question, however important, was likely to receive due attention.

The Royal Society and British Association were founded for the promotion of natural knowledge; the Society of Arts for the encouragement of arts, manufactures, and commerce. The Science Guild, though in sympathy with these objects, is not identical in aim with any existing society. The promotion of natural knowledge is outside its sphere. Its purpose is to stimulate, not so much the acquisition of scientific knowledge, as the appreciation of its value, and the advantage of employing the methods of scientific inquiry, the study of cause and effect, in affairs of every kind. Such methods are not less applicable to the problems which confront the statesman, the official, the merchant, the manufacturer, the soldier, and the schoolmaster, than to those of the chemist or the biologist; and the value of a scientific education lies in the cultivation which it gives of the power to grasp and apply the principles of investigation employed in the laboratory to the problems which modern life presents in peace or war.

Communications may be addressed to the honorary secretary of the British Science Guild, 16 Penywern Road, London, S.W.

SIR WILLIAM WHARTON, K.C.B., F.R.S.

WILLIAM JAMES LLOYD WHARTON, second son of the late Mr. Robert Wharton, County Court Judge of York, was born in London on March 2, 1843. Educated at Burney's Academy, Gosport, he entered the Royal Navy in August, 1857, on board H.M.S. *Illustrious*, then recently commissioned as a training ship for naval cadets, stationed at Portsmouth. Passing with great credit out of the *Illustrious*, he was appointed in April, 1858, midshipman of H.M.S. *Euryalus*, on board which ship H.R.H. Prince Alfred (afterwards Duke of Edinburgh) was also serving. In November, 1860, being appointed to H.M.S. *Jason*, commissioned for service on the North American and West Indian stations, he was lent to H.M.S. *St. George*, employed on fishery duties in Newfoundland during the summer of 1861. On completing his time as midshipman he passed his examination in seamanship for the rank of lieutenant on January 13, 1863. Whilst still serving in the *Jason* he was made acting lieutenant of that ship on October 26, 1864, and at the close of the year, on the *Jason* returning to England to pay off, he at last had the opportunity to pass the examinations in gunnery and navigation necessary to qualify him for the rank of lieutenant. In these he acquitted himself brilliantly, being confirmed in his rank March 15, 1865. In December of that year he was awarded the Beaufort testimonial for passing the best examination of the year in mathematics, nautical astronomy, and navigation.

In the meantime, in July, 1865, he had been appointed to H.M.S. *Gannet*, a sloop commissioned partly for the general duties of the fleet, and partly for surveying service on the North American and West Indian stations, but acting entirely under the orders of the Commander-in-Chief. In that ship he acquired his first experience in the work to which his life was afterwards devoted, receiving the commendation of the Board of Admiralty for the zeal displayed by him on the work performed in the Bay of Fundy. The *Gannet* paid off in November, 1868.

The interest of the Commander-in-Chief, Vice-Admiral Sir James Hope, having been aroused by the ability and industry shown by Lieut. Wharton whilst serving in the *Gannet*, as well as by the distinction which he had gained in passing his examinations, when the admiral hoisted his flag at Portsmouth he offered to Wharton the appointment of flag lieutenant. The hydrographer had meanwhile promised to submit his name as second lieutenant of H.M.S. surveying vessel *Newport*; Wharton consequently considered that his services were pledged to the Surveying Service, although by adhering to it he was fully aware that he would sacrifice the prospect of certain promotion at the end of three years, but this he was prepared to do. Sir James Hope, however, took another view, and speedily arranging matters with the hydrographer, Wharton was appointed as his flag lieutenant on March 1, 1869. Whilst so employed he wrote "The History of H.M.S. *Victory*," which still commands a steady sale to the public, the proceeds being devoted to the R.N. Seamen's and Marines' Orphans' Home, Portsmouth.

In November, 1870, H.M.S. *Urgent* being fitted out to convey astronomers to the neighbourhood of Gibraltar to observe the forthcoming total eclipse of the sun, Sir James Hope gratified his flag lieutenant by permitting him to accompany the expedition as first lieutenant of the ship. He was promoted to commander March 2, 1872, on Sir J. Hope striking his flag, and the following month saw him appointed to the command of H.M. surveying vessel *Shearwater*, first on the Mediterranean station and afterwards on the east coast of Africa. In the Mediterranean his work was chiefly distinguished by a valuable contribution to science in the form of an investigation of the surface and undercurrents in the Bosphorus, setting at rest the many controversies respecting the exhaustless flow of water from the Black Sea to the Sea of Marmora by proving that an undercurrent existed as strong as that on the surface, but which invariably flowed in exactly an opposite direction. His report, which was officially published, may be considered as prescribing the method for similar inquiries. Whilst at Rodriquez, in the South Indian Ocean, he took part in observing the transit of Venus in 1874. The *Shearwater* was paid off in July, 1875, and in June the following year he commissioned the *Fawn* for surveying service in the Mediterranean, Red Sea, and east coast of Africa. Starting with a staff of officers most of whom were wholly inexperienced, Commander Wharton set himself to train them after his own ideals, and succeeded in imbuing his assistants with something of his untiring energy and love of the work. Whilst exacting the utmost that each individual was capable of giving to the service, he exercised unremitting patience and forbearance, and throughout a prolonged commission of four and a half years endeared himself to all who had the happiness to serve under him. He was sympathetic and considerate towards both officers and men, and entered heartily into all schemes for their recreation when opportunity offered. This commission of the *Fawn* was perhaps one of the most successful, as it certainly was one of the happiest, ever spent by a surveying vessel in modern times. The last two years were occupied with the survey of the Sea of Marmora, an excellent piece of work for which he and his officers received an expression of their Lordships' approbation.

On January 29, 1880, Wharton was promoted to captain, and the *Fawn* paid off at Malta at the end of the year.

An interval of leisure then followed, during which Captain Wharton published "Hydrographical Surveying." He expresses himself with characteristic modesty in the preface, but it was at once universally recognised as the standard work on the subject, and has continued to be so considered to the present time, being used both in our own and in foreign navies.

In March, 1882, he commissioned H.M.S. *Sylvia* for surveying service in the River Plate and Straits of Magellan. It was already an open secret that he was destined to succeed Captain Sir Fred. Evans as Hydrographer to the Admiralty when that officer should retire. In December, 1882, he successfully observed the transit of Venus for the second time. The anxieties of two seasons in the inhospitable climate and dangerous waters of the western part of the Straits of Magellan told upon Wharton considerably, and at this time he aged much in appearance. But, full of energy as ever, the work was pushed on rapidly in spite of the hardships and difficulties that had to be encountered, with the result that the survey was completed within the allotted time, and on returning to Montevideo in March, 1884, he left the ship and proceeded to England by mail steamer to assume the duties of hydrographer, being appointed as such on August 1, 1884, at an age younger than that of any officer who had held that responsible position. This closed his career afloat.

Wharton's administration of the hydrographic department of the Admiralty continued uninterruptedly for twenty years with constantly increasing credit, and to the great advantage of our own Navy as well as to the whole maritime world. This period covered the enormous expansion that took place both in the *personnel* and *materiel* of the fleet, causing corresponding accessions to the labour of departmental work; during the same period the number of chart plates was largely increased, and the number of charts printed annually for the fleet and for sale to the public multiplied three-fold.

Gifted with an extraordinary capacity for work, he never spared himself; the sound judgment, breadth of view, and wide scientific attainments constantly brought to bear upon the infinite variety of subjects with which he was daily called upon to deal secured for him the respect and confidence of successive Boards of Admiralty. An especial characteristic was the readiness with which the mass of information he had acquired on all sorts of subjects was available on the spur of the moment. As *ex-officio* member of the Meteorological Council, he attended its meetings assiduously and rendered valuable service to the advancement of ocean meteorology.

His personal interest in the surveying service was unceasingly manifested in the voluminous semi-official correspondence he maintained with the officers in command of surveys. Scientific subjects of whatever nature bearing on hydrography always claimed his attention, and in 1886 he was elected a Fellow of the Royal Society, serving on its council from 1888 to 1889, again from 1895 to 1897, and being again elected in 1904 was a member until his death.

As Fellow of the Royal Astronomical Society, as well as of the Royal Geographical Society, as vice-president of the latter and member of numerous committees, he did work only less important than his official work at the Admiralty. His first contribution to the literature of the Royal Society was the investigation of the great waves produced by the eruptions of Krakatoa in 1882, which had been begun by the late Sir Frederick Evans and left unfinished at his death. In 1893 he edited the journal of Captain Cook during his first voyage round the world; at the meeting of the British Association at Oxford in 1894 he presided over Section E. Various contributions to Nature appeared from time to time from his pen, the investigation of the origin and formation of coral reefs being a subject of especial interest to him. He advanced a theory, based upon the results of surveys of large numbers of these reefs, that the effect of wave action was mainly accountable for the striking uniformity of depth so frequently met with over the interior of coral banks in the open ocean, showing that wave action in open oceans extended to greater depths than was hitherto considered possible.

As a member of the coral reef committee of the Royal Society, he was largely responsible for the selection of Funafuti as the atoll to be investigated by sounding and boring operations, and he was instrumental in securing the cooperation of the Admiralty in the work, which has produced such valuable results.

He was keenly interested in the project for Antarctic exploration, but more particularly in its bearing upon terrestrial magnetism, and he took a very active part as a member of the joint committee of the Royal and Royal Geographical Societies appointed to organise it.

He was placed on the retired list in 1891, in accordance with the regulation respecting non-service at sea. Promoted to Rear-Admiral on January 1, 1895, on the Queen's birthday that year he was nominated as C.B. On the occasion of the Diamond Jubilee in 1897 he was created K.C.B.

On July 31, 1904, Sir William Wharton resigned the office of hydrographer. For some years previously he had suffered much inconvenience and pain owing to an injury to his right wrist received whilst serving in the *Shearwater*; for this and other causes he determined to relinquish the appointment. In July last, after a visit to Aix-les-Bains, he accepted with some hesitation the reiterated invitation to go out to South Africa with a party of members of the British Association, and he presided over Section E at Cape Town. Unfortunately he fell ill on the return journey from the Victoria Falls, and could not return to England as he intended, with his friends, in the *Armadale Castle*. His illness, which was at first thought to be a chill, proved to be enteric fever complicated with pneumonia, and although no effort was spared to effect his recovery he died at the observatory at Cape Town on September 29, where he was the guest of his old and valued friends Sir David and Lady Gill. He was buried at the Naval Cemetery at Simon's Town on October 1 with full naval honours, H.M. the King being represented by the Commander-in-Chief of the station. He was married, in 1880, to Lucy Georgina, daughter of Mr. Edward Holland, of Dumbledon, in Gloucestershire, and by her, who survives him, he had two daughters and three sons, two of whom are now serving in H.M. Navy.

A. M. F.

GEORGE BOWDLER BUCKTON, F.R.S.

One of the most energetic and laborious, as well as one of the oldest of our British entomologists, Mr. George Bowdler Buckton, died on September 25 in his eighty-eighth year. Although he was always interested in natural history, it is somewhat remarkable that, while many men take up the study of entomology in early life and abandon it later, all his important entomological work was executed late in life, and was carried on until a very short period before his death.

Mr. Buckton was born at Hornsey on May 24, 1818. He was privately educated, being debarred from entering a public school by an accident in boyhood which crippled him for life.

Mr. Buckton dedicated his first book, "British Aphides," to Thomas Bell, "a friend of more than forty years' standing" (in 1876), whose sympathy and encouragement had given him a taste for natural history. During the earlier part of his life Mr. Buckton resided in or near London, when his attention was given more to physical than to natural science; and he served as assistant to Prof. A. W. Hofmann at the Royal College of Chemistry. From 1845 to 1865 he published several important papers on chemical subjects (a list of which will be found in the Royal Society's Catalogue of Papers) in the *Journal of the Chemical Society*, the *Proceedings of the Royal Society*, and elsewhere; and his earliest published paper on any entomological subject appears to have been "On the Application of Cyanide of Potassium to killing Insects for the Cabinet," published in the *Zoologist* for 1854, cyanide compounds having been one of his favourite studies during his chemical researches. In the following year (1855) he published a short paper on bats in the second volume of the *Proceedings of the Linnean Society*.

He was a Fellow of the Linnean Society (1845), the Chemical Society (1852), the Royal Society (1857), and the Entomological Society (1883), and was also a member of the Entomological Society of France, a corresponding member of the Royal Academy of Sciences of Philadelphia, &c. He took great interest in these societies, attending their meetings as far as he was able, and occasionally serving on their councils; he also travelled in Italy, France, and other Continental countries, as well as in the British Islands.

In 1865 Mr. Buckton published one of the last of his chemical papers, in conjunction with Prof. W. Odling, whose daughter, Mary Ann, he married in the same year. He then settled at Haslemere, Surrey, for the remainder of his life, where he had purchased the estate at Weycombe, and built himself a house after his own design, with an observatory.

From the time of his residence at Haslemere, Mr. Buckton devoted much of his time to entomology. He formed a collection of Lepidoptera, but paid more attention to the British Homoptera, being much assisted by his children, whom he brought up in the same tastes as his own. He wrote comparatively little in the entomological journals, but published a series of very important entomological monographs from 1876 to 1905, chiefly relating to the somewhat neglected order Homoptera, which will not soon be superseded. They may here be enumerated:—1876–1883, "Monograph of British Aphides" (Ray Society), 4 vols., comprising upwards of 750 pages of letterpress, 9 plain and 134 coloured plates; 1890–1891, "Monograph of British Cicadæ or Tettigidæ" (Macmillan), 2 vols., comprising 426 pages of letterpress, 7 plain and 75 coloured plates; 1895, "The Natural History of *Eristalis Tenax*, or the Drone-Fly" (Macmillan), 1 vol., pp. vii+88, with 1 coloured and 8 plain plates. This work is illustrative of the story of Samson and the Bees. 1901–1903, "A Monograph of the Membracidæ" (Lovell Reeve), 6 parts, comprising upwards of 300 pages of letterpress, and 1 plain and 60 coloured plates. Mr. Buckton's last publication was a supplementary paper to this work, comprising 10 pages of letterpress and 2 coloured plates, forming vol. xi., part ix., of the *Transactions of the Linnean Society*, second series, zoology, and dated July, 1905.

The illustrations to Mr. Buckton's works were all drawn, and the pattern plates coloured, by himself. Some of his plates were even lithographed by himself, and most, if not all, of those which were hand-coloured were coloured by himself or his daughters. The original drawings for the work on Membracidæ have been presented to the Hope Museum at Oxford.

Mr. Buckton kept his genial force and vitality to the end; "his eye was not dimmed, nor his natural force abated." His last illness was of brief duration, and the end was very calm and peaceful. His ashes, after cremation, were deposited in a grave lined with ivy leaves in Haslemere Churchyard on Saturday, September 30.

W. F. KIRBY.

NOTES.

WE regret to see the announcement that Ferdinand Baron von Richthofen, professor of geography in the University of Berlin, died on October 7 in his seventy-third year.

THE sixth annual Huxley memorial lecture of the Anthropological Institute will be delivered on Tuesday, October 31, in the rooms of the Society of Arts, by Dr. John Beddoe, F.R.S., the subject being "Colour and Race."

A JOINT meeting of the Royal Society and the Royal Astronomical Society will be held in the rooms of the Royal Society on Thursday next, October 19, at 4.30 o'clock, to receive preliminary reports on the observations of the recent solar eclipse. It is expected that reports will be presented by the Astronomer Royal, Prof. H. L. Callendar, Mr. J. Evershed, Mr. H. F. Newall, Prof. H. H. Turner, and others.

THE annual "fungus foray" of the Essex Field Club will be held at High Beach, Epping Forest, on Saturday next, October 14; referee, Mr. George Massee, of Kew Museum. Any botanists wishing to attend should communicate with the hon. secretaries of the club, Buckhurst Hill, Essex.

THE death is announced of the Rev. S. J. Johnson at his residence, Melplash Vicarage, near Bridport, on October 9. Mr. Johnson was well known in astronomical circles for his writings upon eclipses and other astronomical matters. He was a Fellow of the Royal Astronomical Society for more than thirty-three years.

SIR EDWARD H. CARBUTT, the eminent mechanical engineer, died suddenly at his residence near Guildford on October 8 at the age of sixty-eight years. He was a past-president of the Institution of Mechanical Engineers, and a vice-president of the Iron and Steel Institute. He was an active member of the board of the National Physical Laboratory, and represented the Iron and Steel Institute on the departmental committee on the Royal College of Science and Royal School of Mines. He also represented the Iron and Steel Institute on the Institution of Civil Engineers' committee to formulate a scheme of education for engineers.

THE Municipal Museum at Hull recently acquired a valuable addition to its collection of local Roman and other remains. The specimens are principally of Roman date, and include more than 2000 coins, nearly 100 fibulæ of a great variety of patterns, several dozen buckles, pins, dress fasteners, ornaments, strap ends, bosses, spindle whorls, armlets, spoons, beads, and other objects. Among the fibulæ are two of exceptional interest, as they bear the maker's name upon them (Aveissa). There is also an extensive collection of pottery, including many vases, strainers, dishes, &c., in grey ware, as well as many fine pieces of Samian ware, several of which contain the potters' marks.

At the meeting of the Institution of Civil Engineers on Tuesday, November 7, an inaugural address will be delivered by the president, Sir Alexander R. Binnie, and the council's awards will be presented. In addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, the council of the institution has made the following awards in respect of other papers dealt with in 1904–5:—a George Stephenson medal to Captain H. R. Sankey, R.E., a Watt medal to Dr. C. Chree, F.R.S.; Telford premiums to Messrs. W. E. W. Millington, C. E. Stromeyer, C. W. Hill, F. C. Lea, W. B. Cole, W. C. Popplewell, E. H. Rigby, and W. O. Leitch, jun. For students' papers the awards are:—Miller prizes to Messrs. A. B. Potts, W. M. Hayman, R. E. Bury, T. Lees, jun., T. L. Matthews, P. J. Risdon, and F. E. Tudor.

The organisation and methods of the Japanese Naval Medical Service recently formed the subject of a communication by Surgeon-General Suzuki to the Association of Military Surgeons at Detroit. Much of the success achieved in the treatment of wounds was ascribed to a regulation requiring every member of the crew of a warship before battle to bathe and dress in perfectly clean underclothing. During engagements a 1 per cent. solution of boric acid was provided to wash the eyes free from powder, smoke, and dust, and cotton-wool plugs for the ears were issued to every man. It was impracticable during action to attempt anything but the most necessary first dressing of wounds, and after action, wherever possible, the wounded were hurried to the base hospital, and only the absolutely essential operations performed on the spot.

Recent issues of the *Proceedings of the Philadelphia Academy* include two papers on polychætous annelids from the North Pacific by Mr. J. P. Moore, and notes on Hawaiian land shells of the families Achatinellidæ and Endodontidæ by Messrs. Pilsbry and Vanatta.

An addition to the useful little guides to the contents of the Horniman Museum at Forest Hill has been issued by the London County Council in the form of "Handbook to the Marine Aquaria," and offered for sale, like all its fellows, for one penny. The handbook commences with an account of the manner in which such receptacles may be made and stocked, followed by notes on some of the common animals which may be kept therein.

We have received part ii. of the ninth volume of the *Transactions of the Leicester Literary and Philosophical Society*, containing the report of the council for the past year. Several lectures, of some of which brief abstracts are published, were delivered during the period under review, and the council reports not only an increased attendance at these lectures on the part of the public, but likewise a successful session as a whole.

A small case has been placed on one of the walls in the central hall of the Natural History Museum for the purpose of showing that the habit of depositing its eggs in the nests of other birds is not confined to the common cuckoo, and that some kinds of cuckoos hatch their own eggs. Among the series is an egg of a cow-bird among a clutch of eggs of a tyrant-bird. In this case the dissimiliarity between the eggs of the two species is very marked, but in a clutch of magpies' eggs among which is an egg of the great south European cuckoo the resemblance is marvellously close.

To the October issue of *Bird Notes and News* Dr. E. A. Wilson, late naturalist on the *Discovery*, contributes an interesting note on penguins, especially with regard to the wholesale destruction of these birds in certain districts for the sake of their oil. As regards the Antarctic species, which are at present unmolested, the author is of opinion that the emperor penguin is secure from attack during the breeding-season, although at other times of the year its destruction could be encompassed, as could that of the Adélie penguin at all seasons. Articles on the protected breeding resorts of gulls and terns in Lancashire and Lincolnshire are included in this number.

The early history of that exterminated race the Morioris of the Chatham Islands forms the subject of two papers in the *Transactions of the New Zealand Institute* for 1904. The author of one of these is of opinion that there was an immigration of Polynesians into New Zealand antecedent to the arrival of the Maories, and it is suggested that the Morioris came among these earlier voyagers. Among a number of zoological papers in the same volume reference may be made to three by Prof. Benham on the earthworms of New Zealand and the Kermadecs, in the course of one of which the author requests that observers will forward specimens from all parts of that area. Attention is directed by Archdeacon Walsh to the alleged existence in New Zealand of an undescribed lizard or salamander. To the geological section Captain Hutton communicates three papers, one on the formation of the Canterbury plains, a second on certain new Tertiary shells, and a third on the Tertiary brachiopods.

"The Cambrian Fauna of China" forms the title of a paper by Mr. C. D. Walcott constituting No. 1415 of the *Proceedings of the U.S. National Museum* (vol. xxix., pp. 1–106). The existence of Cambrian fossils in China was announced in 1883 by Baron von Richthofen, while other specimens were described in 1899. Two years ago the Carnegie Institution of Washington dispatched an expedition for the purpose of obtaining a representative collection of these fossils, and the paper before us is a preliminary account of the collection then made. The fossils of this epoch in China have proved to be extraordinarily abundant, as is indicated by the circumstance that imperfect specimens are scarcely taken into account in this preliminary notice. Brachiopods and trilobites appear to be the dominant forms, and it is confidently expected by the author that important results will follow thorough and systematic exploration and collecting.

Two out of the three articles in the September issue of the *American Naturalist* are of a somewhat technical nature, and interesting to the specialist rather than the general naturalist. In the first Mr. H. Crawley discusses the complex question of the interrelations of the parasitic protozoans of the group Sporozoa, as typified by the gregarines; while in the second Mr. F. C. Baker describes the reproductive organs of the pond-snails of the genus Limnæa. In the third and more popular article Miss Worthington supplies a large amount of information with regard to the life-history of hag-fishes, or myxinoids. These fishes abound in Monterey Bay, where they are taken on the rock-cod beds at a depth of about 300 feet. They live curled around and between the rocks, and when in health always assume a coiled position. Although they will stand much rough treatment, a decided rise of temperature proves fatal. They do much damage by stripping the flesh off fish hooked on the lines. In feeding, the tooth-plate is thrust out of the mouth, with its

two halves divergent, and the flat surface pressed against the fish and the two halves brought together, thereby tearing off a piece of flesh, which is withdrawn into the mouth.

In part i. of the fifth volume of the *Proceedings of the Rhodesia Scientific Association* are contained three papers by the president, Mr. Franklin White. Two of these are descriptions of ruins; the more important paper deals with Zimbabwe on the same lines as the more detailed account in the next issue of the *Journal of the Anthropological Institute*; the illustrations are different. Mr. White's very careful survey shows that many of the data on which have been based theories as to the age and use of the ruins are untrustworthy, and it is unfortunate for him that the negative results of his really sound work have now been overshadowed by the more positive contributions of Mr. MacIver's excavations. The third paper deals with bushman cave paintings near Matopos, and is of interest as showing their occurrence in an area outside that allotted to the "painters" in Stow's recent work; the paintings are reproduced in four coloured plates. Other illustrations in this part show the Lumene and Umnukwane ruins. Few local societies do more useful work than does the Rhodesian Scientific Association, and its *Proceedings* do it great credit.

In the *Naturwissenschaftliche Wochenschrift* for August 13 will be found a *résumé* of our knowledge of carpospore formation in the red seaweeds, which formed the subject of an address by Dr. F. Tobler to the Gesellschaft naturforschender Freunde of Berlin. The article, which deals with the work of Oltmanns and his predecessors, is illustrated with a selection of their figures.

In 1879 Prof. F. C. Schubeler, of Christiania, published some conclusions which he had formed regarding the greater productiveness and quicker ripening qualities of grain sown in northerly districts or on highlands as compared with that sown further south or on lowlands. These conclusions were not without value, as they directed attention to the matter, but Prof. N. Wille questions their accuracy in the *Biologisches Centralblatt* (September 1). Data compiled by Mr. L. P. Nilssen for different Norwegian districts tend rather to show that crops take longer to ripen near the sea than further inland.

The pages of the *Indian Forester* contain a number of useful short notes and letters contributed by officers of the Indian Forest Department, in which they record their experiences and exchange opinions. In the July number Mr. W. Mayes describes a disastrous outbreak of *Trametes pini* in the forests of *Pinus excelsa* in the Simla division; he proposes to replace the diseased poles with deodar, which is believed to be immune to this fungus. A simple but effective method of holding shifting sands by planting thorn hedges is described by Mr. L. Das. The subject of fire protection in teak forests has elicited various expressions of opinion.

The report of the industrial section of the Indian Museum, Calcutta, for the year 1904–5 has been received from the acting superintendent, Mr. Hooper. Among the recent additions to the economic section, the fragrant resin or balsam furnished by *Altingia excelsa*, the dammar-resin secreted by the Melipona or mosquito bee—both products of Burma—and a white resin from Assam, yielded by *Dipterocarpus pilosus*, are of special interest, and have been examined in the laboratory. From Burma specimens have also been sent to the art ware and ethnological sections, but the latter has been augmented principally by collections from Nepal and Tibet of musical instruments, articles of warfare, and personal ornaments.

Although at first glance the disposition of the Lower Palæozoic strata of the Island of Montreal, dipping at a very gentle angle away from the Laurentian plateau, might appear to promise a constant source of artesian water, the mineral character of the rocks forbids this. They are chiefly massive limestones, and the underground water travels along fissures and not in any special water-bearing beds, so that the success or failure of a boring cannot be foretold. Such is the conclusion reached by Prof. Adams and Mr. Leroy from a study of eighty-nine wells (Geological Survey of Canada, annual report, 1904, part O). Their report includes a general account of the geology of the Montreal district, illustrated by an excellent map on the scale of four miles to the inch, so that the pamphlet will be of interest to many who have no concern with well-sinking.

We have received from Dr. P. Bergholz a copy of the observations taken at the Bremen Meteorological Observatory during 1904. The work forms one portion of the excellent series of the "German Meteorological Yearbooks," and contains hourly values and means of the principal elements, together with the daily ranges and other useful tables. It may be remembered that Dr. Bergholz translated into German Father Viñes's very valuable work on the circulation and translation of the cyclones of the West Indies, published in 1895, some two years after the lamented death of the author.

Mr. A. Linton, Director of Agriculture for British East Africa, has published the meteorological records of that protectorate for the year 1904. It is admitted that the observations are not so satisfactory as might be, owing to want of sufficient instruments and of uniformity of exposure, but steps are being taken to remedy both these defects in the near future. The report, however, contains valuable records (mostly of rainfall) at twenty-eight stations, taken at 9h. a.m., during the year 1904, together with monthly and yearly means for as long a period as available, in some cases exceeding ten years. The amount of rainfall varies considerably, according to geographical position; in some provinces the crops suffer from lack of sufficient quantity and in others from excess. The yearly average seems to vary from about 14·7 inches at Kismayu to 73·4 inches at Mumias; both stations are practically in the latitude of the equator, the former station being at 43° E. long., near the sea-level, and the latter at 34° E. long., at an altitude of about 4000 feet.

The large part which her system of secondary and higher education has taken in Germany's extraordinary industrial success forms the subject of an article by Mr. J. L. Bashford in the current number of the *Fortnightly Review*. The essay summarises arguments which have been urged on many occasions in these columns, and advocates forcibly the need for the provision of a generous supply of higher education of the right kind, if Britain is to regain her position in the world of commerce. It is satisfactory to find a growing disposition on the part of the general Press to explain the shortcomings of our national education and to demand the provision of more funds for higher education. The same number of the review contains two other articles of interest to men of science. Dr. C. W. Saleeby, under the title of "The

Problems of Heredity," reviews at length Mr. Archdall Reid's recent book on the subject, and Miss Harriet Munroe gives a picturesque account of a visit to Walpi to study the snake dance.

FROM a study of the spectra of alloys of different metals, photographed under varying conditions of electrical excitation, atmosphere, and the proportions of the components, Mr. P. G. Nutting, of the Washington Bureau of Standards, has arrived at some interesting conclusions which confirm and supplement the results obtained by Lockyer and Roberts in 1873. Mr. Nutting's researches are described in No. 2, vol. xxii., of the *Astrophysical Journal*, and the results may be summarised as follows:—The spectra of the component metals are independent of one another when the alloy is volatilised by either the arc or the spark. The relative intensities of the component spectra are unaffected by variations of the electrical conditions or by substituting hydrogen, oxygen, mercury vapour, &c., for air as the surrounding atmosphere. *Ceteris paribus*, the spectrum of the component which has the greater atomic weight will be the brighter, when inductance is used, either with the arc or with the spark. Under certain conditions—which the author enumerates—spectroscopic analysis of alloys to within an error of about 5 per cent. should be practicable. Mr. Nutting further states that, in practice, the presence of impurities in the electrodes is of little consequence, and that when alloys are used as electrodes it is useless to attempt to intensify the spectrum of either component by varying the conditions under which the arc or spark is produced.

THE American Academy of Arts and Sciences has published a pamphlet giving a brief historical account of the origin of the Rumford fund. This fund had its origin in the gift by Count Rumford—who was born at Woburn, Massachusetts—to the American Academy of Arts and Sciences of the sum of 5000 dollars, which was simultaneous with the gift of a like sum, 1000*l*., to the Royal Society. The purpose of the fund was the same in each case, the award of a suitable premium for discoveries or improvements in heat and light. The gift was accepted by the academy, but for many years no award of the premium was made, as no claimant appeared whose merit was such in its opinion as to justify this. Meanwhile, the fund had accumulated to the amount of 4000*l*., and in view of the fact that there was no possibility of expending the income in the precise manner contemplated by Count Rumford, application was made in 1831 to the Supreme Court of the Commonwealth of Massachusetts for relief, if such should be possible. The court issued a decree which modified the possible disposition of the income of the fund in such a manner as to increase its usefulness while keeping entirely within the spirit of the original gift. At the close of the last fiscal year of the academy (1904–5) the Rumford fund amounted to 11,744*l*., the income for that year having been 510*l*. A standing committee of the academy known as the Rumford committee is charged with the supervision of the trust, and considers all applications for the Rumford premium and all applications made for grants in aid of research. The Rumford committee was first constituted a standing committee in 1833. Its members were nominated annually by the president of the academy until 1863, since which time they have been chosen in the same manner as the other officers. The Rumford fund of the Royal Society has been devoted solely to the award of the premium according to the original provisions of the trust.

OUR ASTRONOMICAL COLUMN.

FURTHER ECLIPSE RESULTS BY FRENCH OBSERVERS.—In No. 13 (September 25) of the *Comptes rendus* M. Salet publishes the preliminary results obtained by his expedition at Robertville (Algeria) during the recent total solar eclipse.

M. Salet was in charge of the mission sent to this station by the Bureau des Longitudes, the chief purpose being to make researches regarding the polarisation of the coronal light.

The first point investigated was the existence of a magnetic field in the neighbourhood of the sun, the presence of such a field being evidenced by the deviation of the plane of polarisation of the coronal light. The result indicated that there is a very slight deviation, amounting to about 2°.5, which seems to show that in spite of its great mass the sun has only a small magnetic field.

A photographic study of the distribution of the polarised light of the corona showed the bands of polarisation decreasing regularly in intensity to about one and a half diameters from the solar limb. The maximum of intensity occurs at about 5′ or 6′ from the limb, and from this distance the bands extend into the inner corona, diminishing in intensity as they approach the edge of the moon. A prominence extending across two bands shows no difference of intensity, thus proving the non-polarisation of these features of the solar atmosphere.

In order to test the atmospheric polarisation, two Savart polariscopes were pointed 90° from the sun, the one towards the pole, the other towards the equator. At this distance the quantity of polarised light during totality was insufficient to observe, although at 30° or 40° from the sun the bands remained visible throughout the period of totality.

To determine the coronal, chromospheric, or atmospheric nature of the corona spectrum lines, a "nicol" was placed so that it covered half the slit of a spectroscope and entirely extinguished the radially polarised light which is *reflected* by the corona. The resulting negative showed that the continuous spectrum of the corona differed in intensity on its two edges because of the suppression of the reflected sunlight, but the light from a prominence showed no diminution in intensity after passing through the "nicol."

The coronium line, which extends to about 4′ from the sun, is seen on both edges, as are the two calcium lines, but the latter are stronger on the edge containing the prominence.

The ultra-violet region of the spectrum, between λ 338 and λ 305, was also photographed, and shows about fifteen lines of which the nature and wave-lengths have yet to be determined.

COSMICAL EVOLUTION.—Some interesting results concerning the processes of cosmical evolution are given in a mathematical discussion, by Mr. J. H. Jeans, of Cambridge University, which appears in No. 2, vol. xxii., of the *Astrophysical Journal*.

The author first directs attention to the extremely small densities usually obtained for such binary systems as that of Algol, and points out that these densities are incompatible with the assumption that such systems are composed of incompressible homogeneous fluids; but the discussions concerning the mechanics of such systems are primarily based on this assumption, and are, therefore, in Mr. Jeans's opinion, deprived of any foundation of fact.

Mr. Jeans then discusses the probable mode of evolution of stellar and planetary systems, and arrives at the conclusion that "gravitational instability" plays the principal part in the segregation of systems from the original nebula. He contends that Laplace's "rotation" theory of cosmical evolution only takes into account a secondary factor in the process, and, in support of the "gravitational instability" theory, he shows that before rotation alone could effect the birth of a satellite a nebulous mass of, say, $10^{33 \cdot 3}$ grams would have to contract until its linear dimension was about $10^{-34 \cdot 5}$ cm., *i.e.* until its density was about 10^{137}.

If the material of the original nebula could be considered as consisting of solid particles such as are assumed

in the meteoritic hypothesis, each meteorite forming a molecule of a quasi-gas, the rotational theory would become more tenable.

VISIBILITY OF FAINT STARS AT THE LOWELL OBSERVATORY.—In No. 7, vol. xiii., of *Popular Astronomy*, Mr. Lowell publishes a chart and some figures which testify eloquently to the "seeing" and the instrumental efficiency at the Lowell Observatory, Flagstaff, Arizona.

In going over a chart of faint stars published by Prof. Tucker for magnitude comparisons, Mr. Lampland found that the faintest stars on the Lick chart were perfectly visible at Flagstaff, although the aperture employed there is only 24 inches, whereas at Lick an aperture of 36 inches is available. In the region following δ Ophiuchi, one of Prof. Tucker's richest fields, 161 stars were shown on the Lick chart. Plotting the same field, independently, Mr. Lampland obtained 173 stars, the greatest increase occurring among the fainter objects. As 15 stars marked on the Lick charts were not found, it follows that 27 were actually seen at Flagstaff which were not recorded by Prof. Tucker. Mr. Lowell remarks that this result is not definitive of what may be charted at his observatory, as moonlight and the rainy season both acted as drawbacks in the present test.

THE ORBIT OF ζ TAURI.—The spectroscopic binary ζ Tauri was included in a list of such objects published by Profs. Frost and Adams in vol. xvii. of the *Astrophysical Journal*, and attention was then directed to the peculiar spectrum of this star. Because of this peculiarity, and also on account of its long period, this object has since been observed regularly at the Yerkes Observatory, and Prof. Adams has determined the orbit, the determination being based on the measurements of the line Hγ on twenty-five plates. Owing to the great breadth of this line duplicate measures were made throughout, and, with the exception of one plate, which was rejected in the discussion, they agreed reasonably well.

The following elements were obtained as a result of the research :—

$u_1 = 100° 13'$	$a \sin i = 27{,}900{,}000$ km.
$\omega = 9° 45'$	Period U = 138 days
$e = 0{\cdot}180$	$\mu = 2°{\cdot}609$
T = 1902 Jan. 19·9	

The largest residual is $-3{\cdot}1$ km., which, considering that the determination is based upon the measurements of only one line, is regarded as satisfactory. No trace of the spectrum of the second component has been found on any of the plates yet secured (*Astrophysical Journal*, September).

THE CONSTANT OF ABERRATION.—As the result of a laborious discussion of more than 15,000 observations, Prof. Doolittle has arrived at the value $20''{\cdot}54$ for the constant of aberration. In publishing this result Prof. Doolittle states that no reasonable weighting of the values will alter it more than $0''{\cdot}01$. The above value agrees very well with the statement made in 1903 by Prof. Chandler, after a very complete investigation, that the real value would be found to be $20''{\cdot}52$, or slightly higher (the *Observatory*, No. 361).

THE NATAL GOVERNMENT OBSERVATORY.—Mr. Nevill's report of the work done in the Natal Government Observatory during 1904 contains but few references to purely astronomical observations, the chief function of the observatory being distinctly meteorological.

THE OPENING OF THE MEDICAL SESSION IN LONDON.

AS is customary, the opening of the medical session has been made the occasion at several of the schools for the distribution of prizes and the delivery of interesting addresses.

At University College, Prof. Kenwood gave an address on "Preventive Medicine, Past and Present," in the course of which he directed attention to the important position occupied by medical practitioners as guardians of the public health, and emphasised the necessity for the adequate teaching of hygiene and public health in the medical schools. He then dealt with the condition of things which should obtain in a hygienic Utopia, and pointed out that while typhus fever had been practically banished and the mortality from scarlatina reduced 80 per cent. during the past thirty years, that from measles had increased. As regards the statement that the practice of hygiene and preventive medicine tends to the preservation of the physically unfit, there is doubtless both a credit and a debit side to the account, and there can be little doubt that the credit side presents a splendid balance.

At King's College the session was opened by Prof. Clifford Allbutt, F.R.S., with an address on "Medical Education." Prof. Allbutt said that in medical education London had its own problems and difficulties, but these could only be solved on principles common to education everywhere and always.

Education must always consist of two parts—the earlier a drawing forth and refining of all the faculties and such a formation of them as habits that a right reason and virtue became easy and pleasant to us; the later the adaptation of these faculties to particular callings. The methods of specific or technical educations were pretty clearly seen; their difficulty was only the difficulty of persuading the British parent of the value of any education whatever, and of the importance of providing for it money, equipment, and time.

The university should be responsible only for a certain universal character of the mind and imagination, a training which could be given in any one of many "faculties." The five years' professional course, all too brief as it was, was now much too heavily loaded. The preliminary sciences occupied so far the larger half of it that little more than a year and a half had to suffice for the study of medicine in all its divisions and subdivisions; and yet upon that formidable burden of subjects some enthusiasts were yearning to pile more and more. The reform which was needed was to teach fewer subjects and to teach them broadly and accurately. In the five years' technical course we ought to begin with the two subjects anatomy and physiology, and teach them on university methods. No subjects made a finer training for hand and mind.

At St. George's Hospital the introductory address was delivered by Mr. Brudenell Carter, who also dealt with medical education and the importance of research. He expressed the opinion that a real and thorough training in physics should form, and eventually must form, the essential groundwork of medical education. Next in importance to physics, as a preliminary subject, he would place such a study of language, it may be of one language alone, as would enable the learner to form clear ideas himself and to express those ideas in a manner clearly intelligible to others.

At Charing Cross Hospital, Sir James Crichton-Browne delivered one of his characteristic addresses. He declared that we have hordes of undergrown, underfed, blemished, diseased, debilitated men, women, and children, who are industrially and socially inefficient; that many of our public institutions are as incompetent as the valves of a damaged heart, and that our educational machinery, our economic system, our municipal administration, and our Army are all inefficient.

If they were to be efficient medical men they must improve their personal efficiency, and see to it that they were physically efficient, intellectually efficient, and morally efficient. For facilitating the attainment of these desirable ends Sir James formulated a series of precepts or principles by which they should be guided.

He dwelt on the necessity for proper exercise and recreation, for proper meals, and for a sufficiency of sleep, declaring that the medical student should have regularly nine hours' sleep in the twenty-four.

At the Middlesex Hospital, Dr. R. A. Young took for his theme "Method in Medicine," and dealt with the need for method in teaching and in study, in research and in practice.

At St. Mary's Hospital an address on "The Public and Medical Education" was given by Dr. Wilfred Harris, in which he stated his conviction that concentration of teaching in the preliminary and intermediate subjects at one or a few centres would make for efficiency, and that one State-controlled examination should take the place of the present multitude of degree and diploma-giving bodies.

Mrs. Bryant, in the course of an address on "Ideals of Study" at the London School of Medicine for Women, said that an ideal of study was most usefully conceived, not as a scheme of learning to be achieved, but rather in its psychological essence as growing out of the primitive intellectual interests of human beings. Interest in knowledge for its own sake—the theoretic interest—was to be found more or less in every healthy normal person. According to brain type, habit, association, and other circumstances, its bent towards one or another branch of knowledge varied in individuals.

It was suggested that more should be done in elementary and secondary education (1) to develop the practical interest in relation to all the every-day problems arising naturally in the environment; and (2) to train it to a high ideal of the science and skill involved in their solution. The neglect of the practical interest in the practically minded was not only loss of good material for practical efficiency; it was also the loss of opportunity for the cultivation of the scientific interest. To inquire how a thing was made led to inquiry as to its causation, and at that point the youth or child becomes athirst for science.

At the London School of Tropical Medicine, Dr. George Nuttall, F.R.S., delivered an address on "Scientific Research in Medicine," in the course of which he pointed out the great benefits to mankind which have followed such discoveries as those of the causes and prevention of yellow fever and malaria, and that the majority of such discoveries have been made by those engaged in research and in the realms of pure science, and rarely by those guided by principles of direct and immediate utility. He urged the necessity for the endowment of research, particularly in experimental medicine, and finally proceeded to review recent work in protozoology and parasitology.

At the School of Pharmacy, Pharmaceutical Society of Great Britain, Sir Boverton Redwood delivered the address on "General Study and Specialism," and at the Royal Veterinary College Mr. Hunting discussed the career of members of the veterinary profession.

DIAMONDS.[1]

FROM the earliest times the diamond has fascinated mankind. It has been a perennial puzzle—one of the "riddles of the painful earth." It is recorded in "Sprat's History of the Royal Society" (1667) that among the questions sent by order of the society to Sir Philiberto Vernatti, resident in Batavia, was one inquiring "Whether Diamonds grow again after three or four years in the same places where they have been digged out?" The answer sent back was "Never, Or at least as the memory of man can attain to."

Of late years the subject has fascinated many men of science. The development of electricity, with the introduction of the electric furnace, has facilitated research, and I am justified in saying that if the diamond problem is not actually solved, there is every probability it shortly will be solved.

South Africa, as I will show in detail, is the favourite haunt of diamonds on this planet; it ranks with Australia and California as one of the three great gold-yielding regions. But the wealth of South Africa is not limited to gold and diamonds. It is also the illimitable home of coal—"the black diamond" of the universe. The province of Natal alone contains more coal than Britain ever owned before a single bucket had been raised; and the coal beds extend into the Orange River Colony. Valuable iron ores exist also in large quantities.

The Pipes at Kimberley.

The five diamond mines are all contained in a precious circle 3½ miles in diameter. They are irregular shaped round or oval pipes, extending vertically downwards to unknown depths, retaining about the same diameter throughout. They are considered to be volcanic necks, filled from below with a heterogeneous mixture of fragments of surrounding rocks, and of older rocks such as granite, mingled and cemented with a bluish coloured hard clayey mass, in which famous blue clay the imbedded diamonds are hidden.

How the great pipes were originally formed is hard to say. They were certainly not burst through in the ordinary manner of volcanic eruption, since the surrounding and enclosing walls show no signs of igneous action, and are not shattered or broken up even when touching the "blue ground." It is pretty certain these pipes were filled from below after they were pierced, and the diamonds were formed at some previous time and mixed with a mud volcano, together with all kinds of débris eroded from the rocks through which it erupted, forming a geological "plum pudding." The direction of flow is seen in the upturned edges of some of the strata of shale in the walls, although I was unable to see any upturning in most parts of the walls of the De Beers mine at great depths.

The breccia filling the mines, usually called "blue ground," is a collection of fragments of shale, and of various eruptive rocks, boulders, and crystals of many kinds of minerals. Indeed, a more wildly heterogeneous mixture can hardly be found anywhere else on this globe. The Kimberley mines for the first 70 feet or 80 feet are filled with so-called "yellow ground," and below that with "blue ground." This superposed yellow on blue is common to all the mines. The blue is the aboriginal ground, and owes its colour chiefly to the presence of lower oxides of iron. When atmospheric influences have access to the iron it becomes peroxidised, and the ground assumes a yellow colour. The thickness of yellow earth in the mines is therefore a measure of the depth of penetration of air and moisture. The colour does not affect the yield of diamonds. The ground mass is soapy to the touch, and friable, especially after exposure to weather. Besides diamonds, more than eighty species of minerals have been recognised in the blue ground, the most common being magnetite, ilmenite, garnet, bright green ferriferous enstatite (bronzite), a hornblendic mineral closely resembling smaragdite, calc-spar, vermiculite, diallage, jeffreysite, mica, kyanite, augite, peridot, iron pyrites, wollastonite, vaalite, zircon, chrome iron, rutile, corundum, apatite, olivine, sahlite, chromite, pseudobrookite, perofskite, biotite, and quartz.

The blue ground does not show any signs of igneous action; the fragments in the breccia are not fused at the edges. The eruptive force was probably steam or water-gas, acting under great pressure but at no high temperature.

There are many such pipes in the immediate neighbourhood of Kimberley. It may be that each volcanic pipe is the vent for its own special laboratory—a laboratory buried at vastly greater depths than we have yet reached—where the temperature is comparable with that of the electric furnace, where the pressure is fiercer than in our puny laboratories and the melting point higher, where no oxygen is present, and where masses of liquid carbon have taken centuries, perhaps thousands of years, to cool to the solidifying point. The chemist arduously manufactures infinitesimal diamonds, valueless as ornamental gems; but nature, with unlimited temperature, inconceivable pressure, and gigantic material, to say nothing of measureless time and appalling energy, produces without stint the dazzling, radiant, beautiful, coveted crystals I am enabled to show you to-night.

This hypothesis of the origin of diamonds is in many ways corroborated.

The ash left after burning a diamond invariably contains iron as its chief constituent; and the most common colours of diamonds, when not perfectly pellucid, show various shades of brown and yellow, from the palest "off colour" to almost black. They are also green, blue, pink, yellow, and orange. These variations give support to the theory advanced by Moissan that the diamond has separated from molten iron—a theory of which I shall say more presently—and also explain how it happens that stones from different mines, and even from different parts of the same mine, differ from each other. Further confirmation is given by the fact that the country round Kimberley is remarkable for its ferruginous character, and iron-saturated soil is popularly regarded as one of the indications of the near presence of diamonds. Along with carbon, molten iron dissolves other bodies which possess

[1] Abridged from a lecture delivered before the British Association at Kimberley on September 5 by Sir William Crookes, F.R.S.

tinctorial powers. One batch of iron might contain an impurity colouring the stones blue, another lot would tend towards the formation of pink stones, another of green, and so on. Cobalt, nickel, chromium, and manganese, all metals present in the blue ground, would produce these colours.

An hypothesis, however, is of little value if it only elucidates half a problem. Let us see how far we can follow out the ferric hypothesis to explain the volcanic pipes. In the first place we must remember these so-called volcanic vents are admittedly not filled with the eruptive rocks, scoriaceous fragments, &c., constituting the ordinary contents of volcanic ducts.

Selections of thin sections of some of these rocks and minerals, mounted as microscopic objects and viewed by polarised light, are not only of interest to the geologist, but are objects of great beauty.

The appearance of shale and fragments of other rocks testifies that the mélange has suffered no great heat in its present condition, and that it has been erupted from great depths by the agency of water vapour or some similar gas. How is this to be explained?

You will recollect I start with the reasonable supposition that at a sufficient depth[1] there were masses of molten iron at great pressure and high temperature, holding carbon in solution, ready to crystallise out on cooling. Far back in time the cooling from above caused cracks in superjacent strata through which water[2] found its way. On reaching the incandescent iron, the water would be converted into gas, and this gas would rapidly disintegrate and erode the channels through which it passed, grooving a passage more and more vertical in the necessity to find the quickest vent to the surface. But steam in the presence of molten or even red-hot iron liberates large volumes of hydrogen gas, together with less quantities of hydrocarbons[3] of all kinds—liquid, gaseous, and solid. Erosion commenced by steam would be continued by the other gases; it would be easy for pipes, large as any found in South Africa, to be scored out in this manner.

Sir Andrew Noble has shown that when the screw stopper of his steel cylinders in which gunpowder explodes under pressure is not absolutely perfect, gas escapes with a rush so overpowering as to score a wide channel in the metal. Some of these stoppers and vents are on the table. To illustrate my argument Sir Andrew Noble has been kind enough to try a special experiment. Through a cylinder of granite is drilled a hole 0·2 inch diameter, the size of a small vent. This is made the stopper of an explosion chamber, in which a quantity of cordite is fired, the gases escaping through the granite vent. The pressure is about 1500 atmospheres, and the whole time of escape is less than half a second. Notice the erosion produced by the escaping gases and by the heat of friction; these forces have scored out a channel more than half an inch diameter and melted the granite along their course. If steel and granite are thus vulnerable at comparatively moderate gaseous pressure, it is easy to imagine the destructive upburst of hydrogen and water-gas grooving for itself a channel in the diabase and quartzite, tearing fragments from resisting rocks, covering the country with débris, and finally, at the subsidence of the great rush, filling the self-made pipe with a water-borne magma in which rocks, minerals, iron oxide, shale, petroleum, and diamonds are violently churned in a veritable witch's cauldron! As the heat abated the water vapour would gradually give place to hot water, which forced through the magma would change some of the mineral fragments into the existing forms of to-day.

Each outbreak would form a dome-shaped hill; the eroding agency of water and ice would plane these eminences until all traces of the original pipes were lost.

Actions such as I have described need not have taken place simultaneously. As there must have been many molten masses of iron with variable contents of carbon, different kinds of colouring matter, solidifying with varying degrees of rapidity, and coming in contact with water at intervals throughout long periods of geological time—so must there have been many outbursts and upheavals, giving rise to pipes containing diamonds. And these diamonds, by sparseness of distribution, crystalline character, difference of tint, purity of colour, varying hardness, brittleness, and state of tension, have the story of their origin impressed upon them, engraved by natural forces—a story which future generations of scientific men may be able to interpret with greater precision than is possible to-day.

[1] A pressure of fifteen tons on the square inch would exist not many miles beneath the surface of the earth.

[2] There are abundant signs that a considerable portion of this part of Africa was once under water, and a fresh-water shell has been found in apparently undisturbed blue ground at Kimberley.

[3] The water sunk in wells close to the Kimberley mine is sometimes impregnated with paraffin, and Sir H. Roscoe extracted a solid hydrocarbon from the "blue ground."

Genesis of the Diamond.

Speculations as to the probable origin of the diamond have been greatly forwarded by patient research, and particularly by improved means of obtaining high temperatures, an advance we owe principally to the researches of Prof. Moissan.

Until recent years carbon was considered absolutely non-volatile and infusible; but the enormous temperatures at the disposal of experimentalists—by the introduction of electricity—show that, instead of breaking rules, carbon obeys the same laws that govern other bodies. It volatilises at the ordinary pressure at a temperature of about 3600° C., and passes from the solid to the gaseous state without liquefying. It has been found that other bodies, such as arsenic, which volatilise without liquefying at the ordinary pressure, will easily liquefy if pressure is added to temperature. It naturally follows that if along with the requisite temperature sufficient pressure is applied, liquefaction of carbon will take place, when on cooling it will crystallise. But carbon at high temperatures is a most energetic chemical agent, and if it can get hold of oxygen from the atmosphere or any compound containing it, it will oxidise and fly off in the form of carbonic acid. Heat and pressure, therefore, are of no avail unless the carbon can be kept inert.

It has long been known that iron when melted dissolves carbon, and on cooling liberates it in the form of graphite. Moissan discovered that several other metals, especially silver, have similar properties; but iron is the best solvent for carbon. The quantity of carbon entering into solution increases with the temperature.

For the manufacture of—I am afraid I must say an infinitesimal—diamond, the first necessity is to select pure iron—free from sulphur, silicon, phosphorus, &c.—and to pack it in a carbon crucible with pure charcoal from sugar. The crucible is then put into the body of the electric furnace, and a powerful arc formed close above it between carbon poles, utilising a current of 700 amperes at 40 volts pressure. The iron rapidly melts and saturates itself with carbon. After a few minutes' heating to a temperature above 4000° C.—a temperature at which the iron melts like wax and volatilises in clouds—the current is stopped, and the dazzling fiery crucible is plunged beneath the surface of cold water, where it is held until it sinks below a red heat. As is well known, iron increases in volume at the moment of passing from the liquid to the solid state. The sudden cooling solidifies the outer layer of iron and holds the inner molten mass in a tight grip. The expansion of the inner liquid on solidifying produces an enormous pressure, and under the stress of this pressure the dissolved carbon separates out in transparent forms—minutely microscopic, it is true—all the same veritable diamonds, with crystalline form and appearance, colour, hardness, and action on light the same as the natural gem.

Now commences the tedious part of the process. The metallic ingot is attacked with hot nitro-hydrochloric acid until no more iron is dissolved. The bulky residue consists chiefly of graphite, together with translucent chestnut-coloured flakes of carbon, black opaque carbon of a density of from 3·0 to 3·5, and hard as diamonds—black diamonds or carbonado, in fact—and a small portion of transparent colourless diamonds showing crystalline structure. Besides these, there may be carbide of silicon and corundum, arising from impurities in the materials employed.

The residue is first heated for some hours with strong sulphuric acid at the boiling point, with the cautious addition of powdered nitre. It is then well washed, and for two days allowed to soak in strong hydrofluoric acid

in cold, then in boiling acid. After this treatment the soft graphite disappears, and most, if not all, the silicon compounds have been destroyed. Hot sulphuric acid is again applied to destroy the fluorides, and the residue, well washed, is attacked with a mixture of the strongest nitric acid and powdered potassium chlorate, kept warm—but not above 60° C., to avoid explosions. This treatment must be repeated six or eight times, when all the hard graphite will gradually be dissolved, and little else left but graphitic oxide, diamond, and the harder carbonado and boart. The residue is fused for an hour in fluorhydrate of fluoride of potassium, then boiled out in water, and again heated in sulphuric acid. The well washed grains which resist this energetic treatment are dried, carefully deposited on a slide, and examined under the microscope. Along with numerous pieces of black diamond are seen transparent colourless pieces, some amorphous, others with a crystalline appearance. Although many fragments of crystals occur, it is remarkable I have never seen a complete crystal. All appear shattered, as if on being liberated from the intense pressure under which they were formed they burst asunder. I have singular evidence of this phenomenon. A fine piece of artificial diamond, carefully mounted by me on a microscopic slide, exploded during the night and covered the slide with fragments. Moissan's crystals of artificial diamond sometimes broke a few weeks after their preparation, and some of the diamonds which cracked weeks or even months after their preparation showed fissures covered with minute cubes. This bursting paroxysm is not unknown at the Kimberley mines.

On the screen I will project photographs of artificial diamonds manufactured in the manner described. So far, these specimens are all microscopic. The largest artificial diamond is less than one millimetre across.

These laboratory diamonds burn in the air before the blowpipe to carbonic acid. In lustre, crystalline form, optical properties, density, and hardness, they are identical with the natural stone.

In several cases Moissan separated ten to fifteen microscopic diamonds from a single ingot. The larger of these are about 0·75 mm. long, the octahedra being 0·2 mm.

Boiling and Melting Point of Carbon.

On the average, the critical point of a substance is 1·5 times its absolute boiling point. Therefore the critical point of carbon should be about 5800° Ab. But the absolute critical temperature divided by the critical pressure is for all the elements so far examined never less than 2·5, this being about the value Sir James Dewar finds for hydrogen. So that, accepting this, we get the maximum critical pressure as follows, viz. 2320 atmospheres:—

$$5800^\circ \text{ Ab.}/\text{CrP} = 2{\cdot}5, \text{ or } \text{CrP} = 5800^\circ \text{ Ab.}/2{\cdot}5, \text{ or } 2320 \text{ atmospheres.}$$

Carbon and arsenic are the only two elements that have a melting point above the boiling point; and among compounds carbonic acid and fluoride of silicium are the only other bodies with similar properties. Now the melting point of arsenic is about 1·2 times its absolute boiling point. With carbonic acid and fluoride of silicium the melting points are about 1·1 times their boiling points. Applying these ratios to carbon, we find that its melting point would be about 4400°.

Therefore, assuming the following data

Boiling point	3870° Ab.
Melting point	4400°
Critical temperature	5800°.
Critical pressure	2320 Ats.

the Rankine or Van der Waals formula calculated from the boiling point and critical data would be as follows:—

$$\log. \text{ P} = 10{\cdot}11 - 39{,}120/\text{T},$$

and this gives for a temperature of 4400° Ab. a pressure of 16·6 Ats. as the melting-point pressure. Similar rough estimates obtained by means of this formula suggest that above a temperature of 5800° Ab. no amount of pressure will cause carbon vapour to assume liquid form, whilst at 4400° Ab. a pressure of above 17 atmospheres would suffice to liquefy some of it. Between these extremes the curve of vapour pressure is assumed to be logarithmic, as represented in the accompanying diagram. The constant 39120 which occurs in the logarithmic formula enables us to calculate the latent heat of evaporation. If we assume the vapour density to be normal, or the molecule in vapour as C_2, then the heat of volatilisation of 12 grms. of carbon would be 90,000 calories; or, if the vapour is a condensed molecule like C_6, then the 12 grms. would need 30,000 calories. In the latter case the evaporation of 1 grm. of carbon would require 2500 calories, whereas a substance like zinc needs only about 400 calories.

A New Formation of Diamond.

I have long speculated as to the possibility of obtaining artificially such pressures and temperatures as would fulfil the above conditions. In their researches on the gases from fired gunpowder and cordite, Sir Frederick Abel and Sir Andrew Noble obtained in closed steel cylinders pressures as great as 95 tons to the square inch, and temperatures as high as 4000° C. According to a paper recently communicated to the Royal Society, Sir Andrew Noble, exploding cordite in closed vessels, has obtained a pressure of 8000 atmospheres, or 50 tons per square inch, with a temperature reaching in all probability 5400° Ab.

Here, then, we have conditions favourable for the liquefaction of carbon, and were the time of explosion sufficient to allow the reactions to take place, we should certainly expect to get the liquid carbon to solidify in the crystalline state.[1]

By the kindness of Sir Andrew Noble, I have been enabled to work upon some of the residues obtained in closed vessels after explosions, and I have submitted them to the same treatment that the granulated iron had gone through. After weeks of patient toil I removed the amorphous carbon, the graphite, the silica,[2] and other constituents of the ash of cordite, and obtained a residue among which, under the microscope, crystalline particles could be distinguished. Some of these particles, from their crystalline appearance and double refraction, were silicon carbide; others were probably diamonds. The whole residue was dried and fused at a good red heat in an excess of potassium bifluoride, to which was added during fusion 5 per cent. of nitre. (Previous experiments had shown me that this mixture readily attacked and dissolved silicon carbide; unfortunately it also attacks diamond to a slight degree.) The residue, after thorough washing and then heating in fuming sulphuric acid, was washed, dried, and the largest crystalline particles picked out and mounted. All the operations of washing and acid treatment were performed in a large platinum crucible by decantation (except the preliminary attack with nitric acid and potassium chlorate, when a hard glass vessel was used); the final result was washed into a shallow watch-glass, and the selection made under the microscope.

I project on the screen a few photographs of these crystals. From the treatment they have undergone, chemists will agree with me that diamonds only could stand such an ordeal; on submitting them to skilled crystallographic authorities my opinion is confirmed. Speaking of the one before you (303), Prof. Bonney calls it "a diamond showing octahedral planes with dark boundaries due to high refracting index." After careful examination, Prof. Miers writes of the same crystal diamond:—"I think one may safely say that the position and angles of its faces, *and of its cleavages*, the absence of birefringence, and the high refractive index, are all compatible with the properties of the diamond crystallising in the form of an octahedron. Others of the remaining crystals, which show a similar high refractive index, appeared to me to present the same features."

[1] Sir James Dewar, in a Friday evening discourse at the Royal Institution, 1880, showed an experiment proving that the temperature of the interior of a carbon tube heated by an outside electric arc was higher than that of the oxy-hydrogen flame. He placed a few small crystals of diamond in the carbon tube, and, maintaining a current of hydrogen to prevent oxidation, raised the temperature of the tube in an electric furnace to that of the arc. In a few minutes the diamond was transformed into graphite. At first sight this would seem to show that diamond cannot be formed at temperatures above that of the arc. It is probable, however, for reasons given above, that at exceedingly high pressures the result would be different

[2] The silica was in the form of spheres, perfectly shaped and transparent, mostly colourless, but among them several of a ruby colour. When 5 per cent. of silica was added to cordite, the residue of the closed vessel explosion contained a much larger quantity of these spheres.

It would have been more conclusive had I been able to get further evidence as to the density and hardness of the crystals; but I am still working at the subject, and hope to add these confirmatory tests. From what I have already said, I think there is no doubt that in these closed vessel explosions we have another method of producing the diamond artificially.

Sensational as is the story of the diamond industry in South Africa, quite another aspect fixes the attention of the chemist. The diamonds come out of the mines, but how did they get in? How were they formed? What is their origin?

Gardner Williams, who knows more about diamonds than any man living, is little inclined to indulge in speculation. In his fascinating book[1] he frankly says:—

"I have been frequently asked, 'What is your theory of the original crystallisation of the diamond?' and the answer has always been, 'I have none; for after seventeen years of thoughtful study, coupled with practical research, I find that it is easier to "drive a coach and four" through most theories that have been propounded than to suggest one which would be based on any non-assailable data.' All that can be said is that in some unknown manner carbon, which existed deep down in the internal regions of the earth, was changed from its black and uninviting appearance to the most beautiful gem which ever saw the light of day."

Meteoric Diamonds.

Another diamond theory appeals to the fancy. It is said the diamond is a gift from Heaven, conveyed to earth in meteoric showers. The suggestion, I believe, was first broached by A. Meydenbauer,[2] who says:—"The diamond can only be of cosmic origin, having fallen as a meteorite at later periods of the earth's formation. The available localities of the diamond contain the residues of not very compact meteoric masses which may, perhaps, have fallen in prehistoric ages, and which have penetrated more or less deeply, according to the more or less resistant character of the surface where they fell. Their remains are crumbling away on exposure to the air and sun, and the rain has long ago washed away all prominent masses. The enclosed diamonds have remained scattered in the river beds, while the fine light matrix has been swept away."

According to this hypothesis, the so-called volcanic pipes are simply holes bored in the solid earth by the impact of monstrous meteors—the larger masses boring the holes, while the smaller masses, disintegrating in their fall, distributed diamonds broadcast. Bizarre as such a theory appears, I am bound to say there are many circumstances which show that the notion of the heavens raining diamonds is not impossible.

The most striking confirmation of the meteoric theory comes from Arizona. Here, on a broad open plain, over an area about five miles in diameter, have been scattered one or two thousand masses of metallic iron, the fragments varying in weight from half a ton to a fraction of an ounce. There is little doubt these masses formed part of a meteoric shower, although no record exists as to when the fall took place. Curiously enough, near the centre, where most of the meteorites have been found, is a crater with raised edges three-quarters of a mile in diameter and about 600 feet deep, bearing exactly the appearance which would be produced had a mighty mass of iron struck the ground and buried itself deep under the surface. Altogether ten tons of this iron have been collected, and specimens of the Canyon Diablo meteorite are in most collectors' cabinets.

An ardent mineralogist—the late Dr. Foote—cutting a section of this meteorite, found the tools were injured by something vastly harder than metallic iron. He examined the specimen chemically, and soon after announced to the scientific world that the Canyon Diablo meteorite contained black and transparent diamonds. This startling discovery was afterwards verified by Profs. Moissan and Friedel, and Moissan, working on 183 kilograms of the Canyon Diablo meteorite, has recently found smooth black diamonds and transparent diamonds in the form of octahedra with rounded edges, together with green hexagonal crystals of carbon silicide. The presence of carbon silicide in the meteorite shows that it must, at some time, have experienced the temperature of the electric furnace. Since this revelation, the search for diamonds in meteorites has occupied the attention of chemists all over the world.

I am enabled to show you photographs of true diamonds I myself have extracted from the Canyon Diablo meteorite. A fine slab of the meteorite, weighing about seven pounds, is on the table before you.

Here, then, we have incontestable proof of the truth of the meteoric theory. Under atmospheric influences the iron would rapidly oxidise and rust away, colouring the adjacent soil with red oxide of iron. The meteoric diamonds would be unaffected, and left on the surface of the soil, to be found haphazard when oxidation had removed the last proof of their celestial origin. That there are still lumps of iron left at Arizona is merely due to the extreme dryness of the climate and the comparatively short time that the iron has been on our planet. We are here witnesses to the course of an event which may have happened in geologic times anywhere on the earth's surface.

Although in Arizona diamonds have fallen from the skies, confounding our senses, this descent of precious stones is what may be called a freak of nature rather than a normal occurrence. To the modern student of science there is no great difference between the composition of our earth and that of extra-terrestrial masses. The mineral peridot is a constant extra-terrestrial visitor, present in most meteorites; and yet no one doubts that peridot is also a true constituent of rocks formed on this earth. The spectroscope reveals that the elementary composition of the stars and the earth is pretty much the same; and the spectroscope also shows that meteorites have as much of earth as of heaven in their composition. Indeed, not only are the self-same elements present in meteorites, but they are combined in the same way to form the same minerals as in the crust of the earth.

It is certain from observations I have made, corroborated by experience gained in the laboratory, that iron at a high temperature and under great pressure—conditions existent at great depths below the surface of the earth—acts as the long-sought solvent for carbon, and will allow it to crystallise out in the form of diamond. But it is also certain, from the evidence afforded by the Arizona and other meteorites, that similar conditions have existed among bodies in space, and that on more than one occasion a meteorite freighted with jewels has fallen as a star from the sky.

Many circumstances point to the conclusion that the diamond of the chemist and the diamond of the mine are strangely akin as to origin. It is evident that the diamond has not been formed *in situ* in the blue ground. The genesis must have taken place at vast depths under enormous pressure. The explosion of large diamonds on coming to the surface shows extreme tension. More diamonds are found in fragments and splinters than in perfect crystals; and it is noteworthy that although these splinters and fragments must be derived from the breaking up of a large crystal, yet in only one instance have pieces been found which could be fitted together, and these occurred at different levels. Does not this fact point to the conclusion that the blue ground is not their true matrix? Nature does not make fragments of crystals. As the edges of the crystals are still sharp and unabraded, the *locus* of formation cannot have been very distant from the present sites. There were probably many sites of crystallisation differing in place and time, or we should not see such distinctive characters in the gems from different mines, nor, indeed, in the diamonds from different parts of the same mine.

It is not difficult to imagine that masses of iron saturated with carbon existed formerly at a sufficient depth below the present mines, where temperature and pressure would produce the reactions which laboratory experiments show to be probable.

Many crystals of diamonds have their surfaces beautifully marked with equilateral triangles, interlaced and of varying sizes. Under the microscope these markings appear as shallow depressions sharply cut out of the surrounding surface; these depressions were supposed by Gustav Rose to indicate the probability that the diamonds at some

[1] "The Diamond Mines of South Africa," p. 510. (Macmillans, 1902.)
[2] *Chemical News*, vol. lxi., p. 209, 1890.

previous time had been exposed to incipient combustion. Rose also noted that striations appeared on the surfaces of diamonds burnt before the blowpipe.

I have tried many times to imitate these markings by partial combustion of clear crystals of diamond, but have not succeeded in reproducing triangles of such beauty as you see formed by nature. According to the crystalline face exposed to incipient combustion the etchings are triangular or cubical, and sometimes intermediate between the two. I throw on the screen magnified photographs of these etchings, and you will observe that while the triangular or box-like tendency is very apparent, there is an absence of regularity and sharpness.

The artificial markings are closer massed, looking as if the diamond during combustion had been dissected into triangular and rectangular flakes, while the markings natural to crystals appear as if produced by the crystallising force as they were being built up.

Certain artificial diamonds present the appearance of an elongated drop. I have seen diamonds which have exactly the appearance of drops of liquid separated in a pasty condition and crystallised on cooling. Diamonds are sometimes found with little appearance of crystallisation, but with rounded forms similar to those which a liquid might assume if kept in the midst of another liquid with which it would not mix. Other drops of liquid carbon retained for sufficient time above their melting point would coalesce with adjacent drops, and on slow cooling would separate in the form of large perfect crystals. Two drops, joining after incipient crystallisation, might assume the not uncommon form of interpenetrating twin crystals. Illustrations of all these caprices are here to-night.

Again, diamond crystals are generally perfect on all sides. They show no irregular side or face by which they were attached to a support, as do artificial crystals of chemical salts; another proof that the diamond must have crystallised from a dense liquid.

Having no double refraction, the diamond should not act on polarised light. But, as is well known, if a transparent body which does not so act is submitted to strain of an irregular character it becomes doubly refracting, and in the polariscope reveals the existence of the strain by brilliant colours arranged in a more or less defined pattern according to the state of tension in which the crystal exists. I have examined many hundred diamond crystals under polarised light, and with few exceptions all show the presence of internal tension. I will project some diamonds on the screen by means of the polarising microscope, and you will see by the colours how great is the strain to which some of them are exposed. On rotating the polariser, the black cross most frequently seen revolves round a particular point in the inside of the crystal; on examining this point with a high power, we sometimes see a slight flaw, more rarely a minute cavity. The cavity is filled with gas at enormous pressure, and the strain is set up in the stone by the effort of the gas to escape. I have already told you that the great Cullinan diamond by this means reveals a state of internal stress and strain.

It is not uncommon for a diamond to explode soon after it reaches the surface; some have been known to burst in the pockets of the miners or when held in the warm hand, and the loss is the greater because large stones are more liable to explode or fly in pieces than small ones. Valuable stones have been destroyed in this way, and it is whispered that cunning dealers are not averse to allowing responsible clients to handle or carry in their warm pockets large crystals fresh from the mine. By way of safeguard against explosion, some dealers imbed large diamonds in raw potato to ensure safe transit to England.

The anomalous action which many diamonds exert on polarised light is not such as can be induced by heat, but it can easily be conferred on diamonds by pressure, showing that the strain has not been produced by sudden cooling, but by sudden lowering of pressure.

The illustration of this peculiarity is not only difficult, but sometimes exceedingly costly—difficult because it is necessary to arrange for projecting on the screen the image of a diamond crystal between the jaws of a hydraulic press, the illuminating light having to pass through delicate optical polarising apparatus—and costly because only perfect, clear crystals can be used, and crystals of this character sometimes fly to pieces as the pressure rises. No colour as yet is seen on the screen, the crystal not being birefringent. A movement of the handle of the press, however, gives the crystal a pinch, instantly responded to by the colours on the screen, showing the production of double refraction. Another movement of the handle brightens the colours; a third may strain the crystal beyond its power of resistance, so I refrain.

Hardness.

Diamonds vary considerably in hardness, and even different parts of the same crystal differ in their resistance to cutting and grinding.

Beautifully white diamonds have been found at Inverel, New South Wales, and from the rich yield of the mine and the white colour of the stones, great things were expected. In the first parcel which came to England the stones were found to be so much harder than South African diamonds that it was at first feared they would be useless except for rock-boring purposes. The difficulty of cutting them disappeared with improved appliances, and they now are highly prized.

The famous Koh-i-noor, when cut into its present form, showed a notable variation in hardness. In cutting one of the facets near a yellow flaw, the crystal became harder and harder the further it was cut, and after working the mill for six hours at the usual speed of 2400 revolutions a minute, little impression was made. The speed was increased to more than 3000, when the work slowly proceeded. Other portions of the stone were found to be comparatively soft, and hardened as the outside was cut away.

I can illustrate the intense hardness of the diamond by experiment. On the flattened apex of a conical block of steel I place a diamond, and upon it I bring down a second cone of steel. With the lamp I project an image of the diamond and steel faces on the screen, and force them together by hydraulic power. I can squeeze the stone into the steel blocks without injuring it in the slightest degree.

The pressure gauge shows 60 atmospheres, and the piston being 3·2 inches diameter, the absolute pressure is 3·16 tons, equivalent on a diamond of 12 square mm. surface to 170 tons per square inch of diamond.

Although not directly bearing on the subject, I will introduce the only serious rival of the diamond as regards hardness. It is the metal tantalum, a fine specimen of which I owe to Messrs. Siemens Brothers. A hole had to be bored through a plate of this metal, and a diamond drill was used revolving at the rate of 5000 revolutions per minute. This whirling force was continued ceaselessly for three days and nights, when it was found that only a small depression ¼ mm. deep had been drilled, and it was a moot point which had suffered most damage, the diamond or the tantalum.[1] In another respect tantalum is likely to rival graphitic carbon, as it has rivalled adamantine carbon. Its thin wire is extensively used for filaments of incandescent electric lamps; it shows a much higher efficiency than does the old carbon filament. The melting point of tantalum is about 2300° C., a temperature seldom or never reached in an ordinary lamp.

Refractivity.

But it is not the hardness of the diamond so much as its optical qualities that make it so highly prized. It is one of the most refracting substances in nature, and it also has the highest reflecting properties. In the cutting of diamonds advantage is taken of these qualities. When cut as a brilliant the facets on the lower side are inclined so that light falls on them at an angle of 24° 13′, at which angle all the incident light is totally reflected. A well cut brilliant should appear opaque by transmitted light except at a small spot in the middle where the table and culet are opposite. All the light falling on the front of the stone is reflected from the facets, and the light passing into the diamond is reflected from the interior surfaces and refracted into colours when it passes out into the air, giving rise to the lightnings, the effulgence, and coruscations for which the diamond is supreme above all other gems.

In vain I have searched for a liquid of the same refrac-

[1] W. von Bolton *Zeitschr. Elektrochem*, ii., 45–51, January 20, 1905.

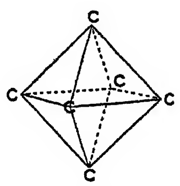
tion as diamond. Such a liquid would be invaluable to the merchant, as on immersing a stone the clear body would absolutely disappear, leaving in all their ugliness the flaws and black specks so frequently seen even in the best stones.

Arguing from theoretical considerations connected with the specific refractive energy of diamond, and employing Lorentz's expression for refraction—

$$\left(\frac{\mu^2-1}{\mu^2+2}\right)\left(\frac{P}{d}\right),$$

in which μ=refractive index, $\mu-1$=refractive energy, d=density, and P=molecular weight, Brühl has shown that diamond is perfectly normal in its optical properties, and has an atomic refraction =5. He has put forward the speculation that the diamond may be the last member of the paraffin series of which marsh-gas is the first.

"Now we can imagine," says Brühl,[1] "why the diamond, *i.e.* pure crystallised carbon, is optically normal. We obtain an idea of the mineral's chemical constitution, and of the way in which the atoms of carbon are perhaps combined in the sparkling gem. The diamond cannot possibly contain any double bonds. Imagine, however, at each of the six corners of a regular octahedron, a single molecule of marsh-gas, CH_4, *i.e.* altogether C_6H_{24}, and then imagine all the 24 hydrogen atoms successively removed, so that each carbon atom is connected with each of its neighbours only by a single bond, and thus all six atoms of carbon are united together in a single whole. Then you obtain, as the most simple representation of the molecule of the diamond, a regular octahedron, with one atom of carbon at each of its six corners, whilst the edges represent the mutual bonds:—



Several simple molecules of this kind may be combined into one crystallised particle of the spectrochemically normal diamond."

Absorption Spectrum of Diamond.

On passing a ray of light through a diamond and examining it in a spectroscope, B. Walter has found in all colourless brilliants of more than one carat in weight an absorption band at wave-length 4155 (violet). He ascribes this band to an impurity, and suggests it may possibly be due to samarium. Three other fainter lines were detected in the ultra-violet by means of photography.

Phosphorescence of Diamond.

After exposure for some time to the sun many diamonds glow in a dark room. Some diamonds are fluorescent, appearing milky in sunlight. In a vacuum, exposed to a high-tension current of electricity, diamonds phosphoresce of different colours, most South African diamonds shining with a bluish light. Diamonds from other localities emit bright blue, apricot, pale blue, red, yellowish green, orange, and pale green light. The most phosphorescent diamonds are those which are fluorescent in the sun. One beautiful green diamond in my collection, when phosphorescing in a good vacuum, gives almost as much light as a candle, and you can easily read by its rays. But the time has hardly come when diamonds can be used as domestic illuminants! The emitted light is pale green, tending to white, and in its spectrum, when strong, can be seen bright lines, one at about λ 5370 in the green, one at λ 5130 in the greenish blue, and one at λ 5030 in the blue.

After many years' bombardment in a vacuum tube this diamond grew very dark, almost black, on the surface. Heating in a mixture of nitric acid and potassium chlorate scarcely changed the colour. The action of heat was then tried, and on slowly heating to about 500° C. the dark colour entirely disappeared, and the original milky green appearance was restored. Although I watched narrowly I could see no trace of phosphorescence during the heating.

Diamonds which phosphoresce red generally show the yellow sodium line superposing on a continuous spectrum. In one Brazilian diamond phosphorescing a reddish yellow colour, I detected the citron line characteristic of yttrium.

By permission of Mrs. Kunz, wife of the well known New York mineralogist, I will show you perhaps the most remarkable of all phosphorescing diamonds. This prodigy diamond will phosphoresce in the dark for some minutes after being exposed to a small pocket electric light, and if rubbed on a piece of cloth a long streak of phosphorescence appears.

Tribo-luminescence.

A few minerals give out light when rubbed, and Mrs. Kunz's diamond is equally striking in this respect. In the year 1663, the Hon. Robert Boyle read a paper before the Royal Society, in which he described several experiments made with a diamond which markedly showed tribo-luminescence. As specimens of tribo-luminescent bodies, I show you sphalerite (sulphide of zinc) and an artificial sphalerite, which is even more responsive to friction than the native sulphide.[1]

Combustion of the Diamond.

When heated in air or oxygen to a temperature varying from 760° C. to 875° C., according to its hardness, the diamond burns with production of carbonic acid. It leaves an extremely light ash, sometimes retaining the shape of the crystal, consisting of iron, lime, magnesia, silica, and titanium. In boart and carbonado the amount of ash sometimes rises to 4 per cent., but in clear crystallised diamonds it is seldom higher than 0·05 per cent. By far the largest constituent of the ash is iron.

Action of Radium on Diamond.

The β rays from radium having like properties to the stream of negative electrons in a radiant matter tube, it was of interest to ascertain if they would exert a like difference on diamond. The diamond glows under the influence of the β radiations, and crushed diamond cemented to a piece of card or metal makes an excellent screen in a spinthariscope—almost as good as zinc sulphide. Some fine colourless crystals of diamond were embedded in radium bromide and kept undisturbed for more than twelve months. At the end of that time they were examined. The radium had caused them to assume a beautiful blue colour, and their value as "fancy stones" had been materially increased. Here are a couple of diamonds originally of the same purity of water. One has been coloured by radium, the other is in its natural state. The colour of the radium-tinted stone is very pronounced. The lantern slide shows the darkening thus produced. A and B are diamonds after twelve months' burial in radium bromide; diamond C is of the original colour.

This blue colour is persistent, and penetrates below the surface. It is unaffected by long-continued heating in strong nitric acid and potassium chlorate, and is not discharged by heating to redness.

To find out if this prolonged contact with radium had communicated to the diamond any radio-active properties, six diamonds were put on a photographic plate, and kept in the dark for a few hours. I will project the image of the result after development. The three on the upper row are the diamonds which have had a prolonged sojourn with radium, the three below are similar diamonds picked out for comparison, which have not been near radium. See how strangely the three upper ones have acted. Notice also that by mere contiguity to the others the lower diamonds also shine with an induced, factitious radio-activity. I throw on the screen a magnified image of one of the blue crystals, and you see in how regular and geometrical a pattern the radio-active emanations radiate from the crystal. This observation has only been made

[1] *Proceedings of the Royal Institution*, May 26, 1905.

[1] Artificial tribo-luminescent sphalerite:—

Zinc carbonate	100 parts
Flower of sulphur	30 ,,
Manganese sulphate	½ per cent.

Mix with distilled water and dry at a gentle heat. Put in luted crucible and keep at a bright red heat for from two to three hours.

a short time, and is still under investigation. Like the blue tint, the radio-activity persists after drastic treatment. To me this proves that radio-activity does not merely consist in the adhesion of electrons or emanations given off by radium, to the surface of an adjacent body, but the property is one involving layers below the surface, and like the alteration of tint is probably closely connected with the intense molecular excitement the stone had experienced during its twelve months' burial in radium bromide.

A diamond that had been coloured blue by radium, and had acquired strong radio-active properties, was slowly heated to dull redness in a dark room. Just before visibility a faint phosphorescence spread over the stone. On cooling and examining the diamond, it was found that neither the colour nor the radio-activity had suffered appreciably.

The diamond is remarkable in another respect. It is extremely transparent to the Röntgen rays, whereas highly refracting glass, used in imitation diamonds, is almost perfectly opaque to the rays. I exposed for a few seconds over a photographic plate to the X-rays the large Delhi diamond of a rose-pink colour weighing 31½ carats, a black diamond weighing 23 carats, and a glass imitation of the pink diamond. On development, the impression where the diamond obscured the rays was found to be strong, showing that most rays passed through, while the glass was practically opaque. By this means imitation diamonds can readily be distinguished from true gems.

I have already signified that there are various degrees of refractoriness to chemical reagents among the different forms of graphite. Some dissolve in strong nitric acid; other forms of graphite require a mixture of highly concentrated nitric acid and potassium chlorate to attack them, and even with this intensely powerful agent some graphites resist longer than others. M. Moissan has shown that the power of resistance to nitric acid and potassium chlorate is in proportion to the temperature at which the graphite was formed, and with tolerable certainty we can estimate this temperature by the resistance of the specimen of graphite to this reagent.

The superficial dark coating on a diamond after exposure to molecular bombardment I have proved to be graphite.[1] M. Moissan[2] has shown that this graphite, on account of its great resistance to oxidising reagents, cannot have been formed at a lower temperature than 3600° C.

It is thus manifest that the bombarding electrons endowed with an electric charge, and striking the diamond with enormous velocity, raise the superficial layer to the temperature of the electric arc, and turn it into graphite, whilst the mass of diamond and its conductivity to heat are sufficient to keep down the general temperature to such a point that the tube appears scarcely more than warm to the touch.

A similar action occurs with silver, the superficial layers of which can be raised to a red heat without the whole mass becoming more than warm.[3]

I will now direct your attention to a strange property of the diamond, which at first sight might seem to discount the great permanence and unalterability of this stone. It has been ascertained that the cause of phosphorescence is in some way connected with the hammering of the electrons, violently driven from the negative pole, on to the surface of the body under examination, and so great is the energy of the bombardment that impinging on a piece of platinum or even iridium the metal will actually melt. When the diamond is thus bombarded in a radiant matter tube the result is startling. It not only phosphoresces, but assumes a brown colour, and when the action is long-continued becomes almost black.

I will project a diamond on the screen and bombard it with radiant matter before your eyes. I do not like to anticipate a failure, but I am at the mercy of my diamond. I cannot rehearse this experiment, and it may happen that the diamond I have selected will show caprice and not blacken in reasonable time. Some diamonds visibly darken in a few minutes, while others, more leisurely in their ways, require an hour.

This blackening is only superficial, but no ordinary means of cleaning will remove the discoloration. Ordinary oxidising reagents have little or no effect in restoring the colour. The black stain on the diamond is due to a form of graphite which is resistant to oxidation.

Conversion of Diamond into Graphite.

Although we cannot convert graphite into diamond, we can change the diamond into graphite. I take a clear crystal of diamond and place it between two carbon poles, and throw the image on the screen by means of a powerful arc lamp behind. I now bring the poles with intervening diamond together and form an arc between. The temperature of the diamond rapidly rises, and when it approaches 3600° C., the vaporising point of carbon, it breaks down, swells, and changes into black and valueless graphite. I show this experiment because it is striking and suggestive. I may add that it is costly—because the stone, if not of fine quality, might easily burst.

[1] *Chemical News*, vol. lxxiv., p. 39, July, 1896.
[2] *Comptes rendus*, cxxiv., p. 653.
[3] *Proc. Roy. Soc.*, vol. l., p. 99, June, 1891.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SIR CLEMENTS R. MARKHAM, K.C.B., F.R.S., will deliver an address at Cambridge on Thursday, October 19, introductory to the courses of instruction in geography.

Science announces the death of General Isaac J. Wistar, of Philadelphia, founder of the Wistar Institute of Anatomy and Biology of the University of Pennsylvania, formerly president of the American Philosophical Society. By his will the Wistar Institute will receive the residue of his estate, thought to amount to about 80,000*l*.

IN the course of an address to the students of Cornell University in 1903, President Schurman emphasised the necessity of a systematic distribution of the daily time of college students. He recommended the following general apportionment of hours:—for work, eleven; for sleep, eight; for amusement, one; for meals and athletics, two hours each. Work is made to include not only time spent in the laboratory and lecture-room and in private study, but also time given to societies and to self-support. This advice led Dr. Guy M. Whipple, of Cornell University, to try to ascertain how the students in his university actually do distribute their daily time. The results of his inquiries are described in an article in the current number of the *Popular Science Monthly*. In the summary to the detailed tables given in his article Dr. Whipple states that, taking the university as a whole, the average Cornell student devotes just nine hours daily to college work, sleeps 7·9 hours, devotes 2·23 hours to amusement, 1·72 hours to physical exercise, 1·4 hours to meals, 0·39 hour to self-support, and 1·36 hours to unclassified activities. The average length of time given to work is greatest in the college of medicine, and progressively less in those of engineering, law, agriculture, and arts. Both in the university at large and within the College of Arts and Sciences, men give more time to college work than women.

PROF. J. W. JUDD, F.R.S., distributed on October 5 the medals and prizes gained during the past session by the students of the Royal College of Science, London, in the lecture theatre of the Victoria and Albert Museum, South Kensington. The Dean, Prof. Tilden, F.R.S., in opening the proceedings, referred with regret to several losses which the college and school had sustained during the year, alluding particularly to the death of Prof. Howes. The geological division had lost its chief by the retirement of Prof. Judd. The college is now, the Dean continued, in an attitude of expectancy in regard to the future, and it is possible that next year they will be able to hold the prize distribution in the new buildings. He said that in ten years seventy-six of the students of the college have taken the degree of B.Sc., and, in addition, thirty have taken first-class honours, besides which there are nine doctors of science. Prof. Judd, having distributed the awards, addressed the students. He acknowledged the uniform courtesy and consideration which he had received from colleagues and students alike during his forty-five years' experience in connection with the school. Nearly two-thirds of that period had been spent in the position of one of the teachers. He congratulated them on the expansion and development which is now promised, and expressed the hope that the change would lead to even

greater successes in the future than have been attained in the past. Mr. R. L. Morant, permanent secretary of the Board of Education, in moving a vote of thanks to Prof. Judd, said the college stood for the essential necessity of practical work as a proper means of the study of science.

THE new College of Hygiene and Physical Training instituted by the Carnegie Dunfermline trustees, which was described in our issue for September 28 (p. 550), was opened formally on October 4 by Lord Linlithgow, Secretary for Scotland and vice-president of the Council of Education in Scotland. The chairman, Dr. John Ross, delivered the opening address. He said the work of the college is to be two-fold. Following the method established for the training of the teachers in elementary schools, there is provided first what may be called a great practising school with 4500 pupils, consisting of all the school children, and next there is the college proper, consisting of young women prepared to adopt the teaching of physical culture as a profession, or to acquire for their own personal benefit a knowledge of themselves and the most rational rules of life. As yet only young women are to be received, but it is anticipated that it will be possible in the near future to receive young men. Lord Linlithgow, during the course of an interesting speech, said there is no doubt that the country is waking up to the necessity of some sort of physical training for young people, and to the necessity of a better understanding of the laws of hygiene. It is well that the public should understand what physical training means. Lord Linlithgow defined it as the careful development of the general health to the advantage of the whole body, and indirectly to the advantage of the mind. The Carnegie trustees are, he continued, doing a great and valuable service to Scotland in taking up this subject. They are doing a work which no school board can do, for it is doubtful whether public opinion has as yet ripened sufficiently to allow the Education Department to apply any considerable portion of the national funds to a purpose of this kind. It will come in time, for the public is taking an increasing interest in all that concerns the feeding, the management, the cleanliness, and physical welfare of the young generation. It is being recognised more and more that the amount of information, or book-learning, which a child acquires at school is a matter of comparatively little importance. What is wanted is the healthy training of the boy or girl both physically and mentally.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, July 14.—"The Phagocytosis of Red Blood-cells." By Dr. J. O. Wakelin **Barratt**. Communicated by Sir Victor Horsley, F.R.S.

The author has investigated the conditions under which phagocytosis of red blood-cells, by means of leucocytes, is brought about. Metchnikoff, who studied this process, attached great importance to the part played by the leucocytes, but Sawtchenko discovered that the chief factor in the production of this form of phagocytosis is sensibilisation of the red blood-cells, which can be brought about by the serum of animals which have been previously injected with the variety of red blood-cells employed for phagocytosis, and he attributed the action of the serum to the presence of amboceptor (immunisine, fixateur). That this is not so, however, is shown by the circumstance that, in the absence of amboceptor, strongly marked phagocytosis may be brought about by serum, and further experiments showed that the effective constituent is an opsonin. In addition, it was found that erythrocytic opsonins are sometimes present, usually in relatively small quantities, in normal sera, and in suitably chosen conditions of experiment may be used to prepare red blood-cells for ingestion by leucocytes.

PARIS.

Academy of Sciences, October 2.—M. Troost in the chair.—Summary of the observations of the solar eclipse of August 29–30 made at Sfax, Tunis: G. **Bigourdan.** Light clouds were present during the eclipse, but were not sufficiently numerous to interfere seriously with the observations. Particulars are given of the determination of time, the observations of the contacts, the photography of the inner corona, the monochromatic photography of the corona, the work done with the spectrographs, ocular and photographic photometry, the influence of the passage of the shadow on the magnetic state of the earth, meteorology and actinometry, drawings made with the naked eye, observation of the moving shadows, the darkness during the eclipse, and the visibility of the stars.—On the laws of sliding friction: Paul **Painlevé.** An extension of the results obtained in a previous paper and a reply to some objections.—Observation of the eclipse of the sun of August 30 at the Observatory of Marseilles: M. **Stéphan.** The atmospheric conditions were quite satisfactory. The times of first and second contact are given, and the changes of temperature were automatically registered.—On some differential equations of the second order: Richard **Fuchs.**—On minimum surfaces: S. **Bernstein.**—Experimental verifications of the undulatory form of the photographic function: Adrien **Guébhard.**—On isostrychnine: A. **Bacovesco.** Isostrychnine is obtained hy heating strychnine with water in sealed tubes at 160° C. to 180° C. The colour reactions of the isomer resemble those of the original alkaloid, but there are points of difference. The poisonous properties of the isomer are less marked than in strychnine, and, indeed, rather approximate to those of curare. That the two alkaloids are structurally different is shown by the action of sodium ethylate, which converts isostrychnine integrally into the isostrychnic acid of Tafel. —On the mode of propagation of some aquatic plants: Louis **François.**—On the geology of the Sahara: R. **Chudeau.**—On the direction of the permanent magnetisation of a metamorphic clay from Pontfarlin (Cantal): Bernard **Brunhes.**

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THURSDAY, OCTOBER 19, 1905.

MECHANICS FOR STUDENTS.

Mechanics: a School Course. By W. D. Eggar, Pp. viii+288. (London: Edward Arnold, 1905.) Price 3s. 6d.

Elements of Mechanics. By Prof. Mansfield Merriman. Pp. 172. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 1 dollar net.

An Intermediate Course of Mechanics. By A. W. Porter. Pp. viii+422. (London: John Murray.) Price 5s.

MR. EGGAR is doing good work in the movement which aims at the extension of quantitative measurements in the courses of mathematical studies for youths, and a school book of mechanics from the author of the well known experimental introduction to geometry is sure to be received with favour and interest by teacher and pupil alike. We may say at once that readers are not likely to be disappointed, for the experimental work on which the fundamental principles are based is simple, suggestive, and thorough, and the essence of the subject is not obscured by an undue amount of mathematical dressing.

The first five chapters are concerned with the verification and elucidation of Newton's laws of motion, and some very efficient apparatus is introduced and described in this admittedly difficult portion of the subject; we agree with the author that "velocities, accelerations, moments, work, and momentum can be made clear to a student if he has to measure them." Experiments of Galileo by means of which the laws of falling bodies were discovered are introduced with suitable modifications; a clever method of measuring time by the use of a vibrating spring carrying a paint brush (due to Mr. Fletcher) is employed, and altogether this section, treating kinetics experimentally, is most interesting and very satisfactory. The next five chapters relate to statics and the equilibrium of forces, and the remaining portion of the book deals with work, friction, simple machines, projectiles, circular and simple harmonic motions, stress and strain, and fluids.

There is little in the book to which exception can be taken. When the author seems to imply that the unit of force in the "engineer's" system is a variable quantity, he appears to misapprehend the system. The experiments on change of motion are confined to straight-line motion. The student would have been led to a more comprehensive view of the subject if there could have been introduced an experiment illustrating vector change in plane motion, accompanied by the plotting of a hodograph. Then, instead of resorting to an antiquated and non-instructive proof for the acceleration in uniform circular motion, the hodograph could have been used to illuminate the principle that force is the time rate of change of momentum.

The test is arranged so that statics can be taken before kinetics if this procedure is thought desirable, but the sequence adopted by Mr. Eggar seems to us the right one. In addition to the experimental work, numbers of good and suggestive exercises are provided at appropriate intervals. The author has succeeded in producing a most admirable text-book, and one which we should like to see largely used throughout the schools of the country.

The aim of Prof. Merriman in his volume is to introduce mechanics to young engineering students in a manner whereby the principles are established by constant appeals to experience, and are not lost sight of by the introduction of a mass of algebraical matter. The intention is good, but the experience should be that gained first-hand by the student himself from experimental work in a laboratory. The method employed by the author is to base the science on axioms which the reader has to take largely on trust. After the first four pages, six of these are suddenly introduced. Thus:—"*Axiom* 1. Where only one force acts on a body, it moves in a straight line in the direction of that force."

As a professor of civil engineering, the author naturally gives more attention to statics than to dynamics. In fact, the latter branch is very feebly presented, and the subject does not gain by the substitution of the axioms for Newton's laws. For example, the fundamental principle that impulse is equal to change of momentum is nowhere found. For the acquirement of a knowledge of the subject reliance is largely placed on the working of the four hundred problems, mostly numerical, which are spread over the book.

In Prof. Porter's elementary text-book of theoretical mechanics the subject is presented so as to appeal to physicists rather than to engineers. Students reading for the intermediate pass examination of London University will find the book very helpful. A few experiments in verification of the laws of mechanics are described, but the treatment is almost wholly deductive. The author begins by discussing the kinematics and kinetics of the rectilinear motion of a rigid body, and is very happy in his explanations of the fundamental conceptions of space, time, mass, momentum, &c., particular attention being paid to the units of measurement and to the change from one set of units to another. In defining the several systems, however, the author seems to be mistaken in his view that the unit of force adopted by engineers is a variable one depending upon latitude.

The consideration of the mechanics of a particle is preceded by a chapter on the addition of vectors, in which some elementary trigonometry is introduced. The author might here have improved his definitions of the trigonometrical ratios for angles of any magnitude by making use of the projections of a rotation vector. The action of couples and the dynamics of rigid bodies having plane motion are next considered, and very logically, but here a few additional experiments personally carried out would have materially added to the student's grip of this somewhat difficult part of the subject. There is a chapter dealing mathematically

with some simple mechanical contrivances such as the wedge, screw, lever, and pulley; another on simple harmonic motion, in which the pendulum is rather fully dealt with; and then follows a chapter devoted to the mechanics of fluids, and comprising an examination of the stability of floating bodies. The book concludes with a chapter on units and dimensions.

Sets of examples are given, the numerical answers being collected at the end of the volume. Specimens of recent intermediate science examination papers of University College in connection with the University of London are appended. Some will regret that the author does not assume a slight acquaintance with the Calculus such as must be possessed by most readers of the book. But taken altogether the subject is dealt with very thoroughly, and developed naturally and logically, and the book deserves a wide circulation.

MUSIC OF SINGING-BIRDS.

Field Book of Wild Birds and their Music. By F. Schuyler Mathews. Pp. xxxv+262. (New York and London: G. P. Putnam's Sons, 1904.) Price 2 dollars.

THIS is a very pretty little book, with many charming illustrations of American singing-birds, and numerous attempts to represent their songs in our musical notation. It would seem as if the songs of American birds lent themselves more readily than those of our European species to such notation, for this is by no means the first attempt of this kind which has recently been made on the other side of the water. The present reviewer is under the disadvantage of not having heard these birds in their native land, and is quite ready to believe that Mr. Mathews's musical notations may give an American some vague idea of what his birds sing; at the same time, as one whose knowledge of music is even older than his knowledge of birds, he must emphatically express a hope that British ornithologists will not imitate their American brethren in trying to render our familiar songs on this system. Our music is a highly artificial product, subject to strict limitations which have gradually been placed upon it as the art has developed in the course of many centuries; and to attempt to catch and (so to speak) to tame the songs of wild birds, bringing them forcibly under conditions which entirely deprive them of their natural freedom in regard to pitch, scale, time, and rhythm, is in almost all cases to do them cruel violence. A very few of our birds—the cuckoo, for example, and the song-thrush—have vocal utterances which can be expressed on our musical scale; but by far the greater number can only be represented in the amusing way in which Mr. Mathews has noted the song of the bobolink on pp. 50 and 51—by a cloudy jumble of notes and lines above the stave, which suggests a flute-player gone mad.

The sentence which he has prefixed to this curious bit of notation really explains his object and method, and forbids us to take him too scientifically. He says, "If one prefers not to *interpret* bird-music, but to take it from Nature exactly as it comes, this bit that follows may prove acceptable." What he has really been trying to do, it seems, is to *interpret* bird-music, by which he means that he has listened to it with a musical mind, and has gained from it certain musical impressions, which he again interprets to us in the language of our musical art, not only in the form of melody confined in the fetters of our musical scale, but in many cases enriched with ingenious accompanying harmonies. The reader will find a good illustration of this method in the treatment of the song of the American song-sparrow, pp. 110 foll. It is the method pursued by all who seriously attempt to transfer the notes of birds to music-paper, though it may be doubted whether they would all acknowledge this as frankly as Mr. Mathews. It follows that our knowledge of bird-music is not really increased by these efforts, charming and interesting as they often are to the musician; for what is put upon paper is not the song of the bird, but an interpretation of it by an artistic mind. Taken in this light, this little book may give much pleasure, and may add a good deal to our knowledge of some delightful American songsters.

W. W. F.

OUR BOOK SHELF.

Studien ueber Hautelektricität und Hautmagnetismus des Menschen. By Dr. Erik Harnack. Pp. 65. (Jena: Gustav Fischer, 1905.) Price 1.60 marks.

THE author takes a pocket-compass, about the size of a lady's watch, with metal case and watch-glass top, and having placed it on a level surface lightly rubs the glass with the tip of his finger. The needle is immediately deflected from the magnetic meridian, remaining so for a minute or more, and then returning to its original position. That magnetism has nothing to do with it is shown by the fact that the same phenomenon occurs when for the magnet there is substituted a needle of nickel, platinum, zinc, bismuth, or ivory, although the absence in such cases of a directive force makes it more difficult to observe. Static charges, apparently much stronger, are without effect. Some people can influence the needle much more than others, and the author's power is not always equally strong.

Quantitative experiments were undertaken by the author to measure the E.M.F. induced by rubbing a glass plate of the same size and shape in the same manner. Using a Braun electrometer graduated up to 1500 volts, the maximum value obtained by him was 1300 volts. It seems evident that a strong electric charge is developed on a part of the glass surface by the friction of the finger upon it, and that the needle being free to move, and, moreover, in metallic connection with the case, is attracted by the charged surface.

This is not disputed by the author, his contention being that the magnitude of the effect is out of all proportion to the force expended, and that, therefore, it is not due to physical but to physiological causes set in action by the slight friction of the finger-tips. In the present writer's opinion this contention is certainly not substantiated. The total energy of the charge of a condenser composed of a compass-needle and a square centimetre or so of glass with a P.D. of a thousand or, for that matter, of ten thousand volts is trifling, and since the work actually done consists in the mere turning of the needle through 90°, one is driven to ask whether if a cocoon fibre were attached to the end of the needle and to the

operator's finger he would be able to feel the pull of the earth's magnetic force upon it. The work done by a few light touches of the finger must be amply sufficient to furnish all the energy required to deflect the needle. But to a modern electrician it certainly seems a remarkably efficient transformation.

GEORGE J. BURCH.

An Introduction to the Study of Colour Phenomena. By Joseph W. Lovibond. Pp. 48; 10 coloured plates. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1905.) Price 5s. net.

THE author states that his object has been to supply the long-felt want of a power of recovering a given colour sensation and of a colour nomenclature by which that sensation may be quantitatively described. To this end "scales of red, yellow and blue were constructed of glass slips, the slips of each scale being all of one colour with a regular variation in intensity from 0.01 to 20 units, equal units of the three scales being in colour equivalence with each other. . . . The test of equivalence is that a white light viewed through equal units of the three scales should give no evidence of colour. . . . The fogs on Salisbury Plain furnished the light actually used." It was found that red, yellow, and blue were the only colours suitable for systematic work, and that any colour could be produced by their combination. The dimensions of the unit are, it is said, necessarily arbitrary, but the scale-divisions are equal, while the unit itself is recoverable.

The colour to be tested is matched by that of the light transmitted by one of the glasses, or by several superposed, equality of luminosity being secured, when necessary, by the interposition of a neutral-tinted combination between the eye and the coloured object. A specification of the glasses employed is registered, according to certain rules, as a formula which defines in terms of the author's constants the colour "developed," and supplies data for its future reproduction.

To those who are accustomed to regard the spectrum as the natural basis of colour experiment the author's method cannot but appear crude and unscientific; but, given a sufficient supply of carefully selected glasses, it is probable that much useful work might be done in a rough and ready way by its means. An example occurs in the quantitative study of the colour of the human blood in health and in disease, which is illustrated in plate vi.

The book concludes with an exposition of Mr. Lovibond's new theory of colour.

Index Phytochemicus. By Drs. J. C. Ritsema and J. Sack. With introduction by Dr. M. Greshoff. Pp. 86. (Amsterdam: J. H. de Bussy.)

DR. GRESHOFF explains in the introduction to this volume that it originated in a card index to the literature of plant chemistry compiled for use in the laboratory of the Colonial Museum at Haarlem, where the work carried on consists principally of the investigation of the proximate constituents of plants.

The index enumerates the names of more than two thousand plant constituents, and gives in each case the percentage composition, formula, melting or boiling point, and at least one reference to the literature —usually Beilstein's "Handbuch," though in a few cases the references are to original papers. The volume also contains a short but useful bibliography of plant chemistry.

The information given in the tables, so far as can be judged from trials in a few cases, appears to be accurate, and the index should prove useful to chemists engaged in the investigation of plant products.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Eclipse Predictions.

IT is always interesting to compare the results of observation with those predicted by calculation. In the case of the recent total eclipse of the sun this is rendered difficult by the want of agreement in the predictions of the two most used authorities, the Nautical Almanac and the Connaissance des Temps. The discrepancies in the predicted duration of totality and of the breadth of the band traced on the earth's surface by the total phase are made apparent in the following table. It is compiled from the table in the Nautical Almanac headed "Limits of total phase of the Solar Eclipse," and the corresponding table in the Connaissance des Temps entitled "Limites de l'Éclipse totale et Durée de la Phase totale sur la Ligne centrale." Entries for as nearly as possible the same time in each table have been taken and are placed together:—

Column A contains the authority, Nautical Almanac (N.A.) or Connaissance des Temps (C.T.).

Column B contains the time (G.M.T.) for which each prediction is made.

Column C contains the calculated distance (in nautical miles) and the bearing of the northern limit of totality from the corresponding southern limit.

Column D contains the durations of totality on the central line as predicted by the one authority and (in brackets) as interpolated from the prediction of the other.

Column E contains the differences of these pairs of values.

A	B	C		D		E
	1905 Aug. 30 G.M.T.	Distance	Bearing	N.A.	C.T.	
	h. m.	′	°	secs.	secs.	secs.
C.T.	0 22	113·5	N. 1 W.	(198 4)	206	7·4
N.A.	0 24	101·5	,, 2 W.	200·6	(208)	7·6
C.T.	0 35·2	109·5	,, 2 E.	(211)	219	8·0
N.A.	0 36	102	,, 11 ,,	211·8	(219·5)	7·7
C.T.	0 50·3	114	,, 6 ,,	(220·2)	228	7·8
N.A.	0 48	104	,, 19 ,,	219·1	(227·4)	8·3
C.T.	1 7·0	116·5	,, 10 ,,	(223 8)	231	7·2
N.A.	1 8·0	104	,, 31 ,,	223 8	(231·2)	7·4
N.A.	1 24	105·5	,, 37 ,,	22 ·7	(226·6)	5·9
C.T.	1 24·9	116·5	,, 12 ,,	(220·2)	227	6·8
C.T.	1 43·1	115	,, 14 ,,	(209·2)	215	5·8
N.A.	1 44	106	,, 44 ,,	208·4	(214)	5·6

It will be seen that, for stations in Spain and the adjacent Mediterranean, the duration of totality on the central line was predicted by the French authority to be from seven to eight seconds longer than by the British authority. In the same region, the width of the band of totality is from ten to eleven nautical miles greater by the French than by the British prediction. The orientation of the line connecting the two limits of totality also differs considerably in the two tables.

It is reported that at Sousse and Gabes, two towns in Tunisia, the eclipse was partial, while a total eclipse had been predicted for them. The prediction for these places would surely rest on French authority; we are therefore entitled to conclude that the mistake has been made by the French calculators. An excessive estimate of the width of the band of totality would almost certainly be accompanied by an excessive estimate of the duration of totality, and the table shows that both estimates are considerably greater in the Connaissance des Temps than in the Nautical Almanac.

J. Y. BUCHANAN.

October 13.

Absence of Vibration in a Turbine Steamship.

RETURNING homeward to Paris the middle of September from the Tripoli eclipse, and finding passage to America difficult to obtain, I chanced to learn that the triple-screw turbine steamer R.M.S. *Virginian* was sailing from Liverpool for Montreal on September 30, so I was very glad to have the opportunity of a voyage in a ship full powered with this novel type of propulsion. After a week on board I have no hesitation in saying that for freedom from

the nerve-annoying tremors incident to the usual reciprocating engines, the *Virginian* has proved far and away the quietest steamship I have ever voyaged on. Excellent evidence of this, I think, lies in the exceptionally large number of passengers who dined comfortably in the saloon at the roughest period of our entire passage. There was a fairly heavy sea on, and the ship was by no means free from wave-origined motion. So I am quite of the opinion that sea-sickness and all its train of discomforts must be greatly aggravated by the engine-borne tremors of the ordinary steamship, and that many people who are delicate sailors under ordinary conditions might take ocean journeys with comparative comfort in a turbined ship.

So unostentatious are the rotary engines of the *Virginian,* let alone their occupying but one-fourth the space of the usual expansion engines, that the quietness of their powerful and effective working, in every part of the ship, was continually deceiving one into thinking that the vessel had lost headway, or might have come to anchor altogether. Especially was this true in the dining saloon, that most critical of all spots, where one could rarely detect so much as a ripple on water in a glass, although going ahead at full speed of 15 knots.

To my mind the *Virginian* seemed to behave all the voyage quite as if her motive power were entirely without her; in fact, she could scarcely have ridden more smoothly, or with less of that exasperating vibration (the unceasing action of which, I am convinced, is a prominent factor in inducing *mal de mer*), if she had been towed at the identical speed by a huge hawser. DAVID TODD.

R.M.S. *Virginian*, Straits of Belle Isle, October 4.

A Parasite of the House-fly.

REVERTING to the recent correspondence under this heading between Mr. Davenport Hill and Prof. Hickson (NATURE, August 24 and 31), I recall that a few years back many house-flies with Chelifers attached were sent to me at the Natural History Museum for determination of the species and explanation of the phenomenon. The first task was as easy as the second was difficult. The Chelifer was in most, nay in all, cases, so far as my memory serves, *Chernes nodosus.* But those who suggest that the explanation is to be sought and found in the value of the habit as a means of securing dispersal hardly realise, I think, the difficulties in the way of its acceptance. Chelifers are minute, active, and, for arthropods, not exceptionally prolific. Hence the sufficiency of "elbow-room" for the survivors of a family of, say, forty, on the site chosen by the female for her progeny does not coincide with the view that they have special need of transportation. Moreover, when we remember that a Chelifer attached to a fly is exposed to the danger of being killed by the enemies of that insect, and also to the great chance of being landed in a wholly unsuitable environment, it can hardly be maintained that the advantage derived from this method of dispersal has been a sufficiently important factor in survival to preserve and foster an initial instinct to grab and hang on to the legs of flies. That the aërial porterage thus secured, whether fortuitously or "intentionally," must be a means of dispersal is too obvious to dispute; but I do not think more than that can be claimed for it, since it is as likely to end in failure as in success.

Chelifers may be found not uncommonly beneath the wing-cases of large beetles. Presumably this habitat has been adopted for the sake of the food supplied by the parasitic mites infesting the beetles. This fact, I think, suggests a line of investigation which may lead to a more satisfactory explanation of the association between Chelifers and flies than that put forward in Prof. Hickson's letter.

Zoological Gardens, October 14. R. I. POCOCK.

Incandescence of Meteors.

IT is with great diffidence that I approach this difficult subject, but the theory that the incandescence of meteors is due to the heat generated by the friction between these bodies and the molecules of gas composing our atmosphere I have always found difficult to believe. The following theory is one which has occurred to me, and seems quite a plausible one. Meteors are usually of a metalliferous nature, and consequently will have a comparatively low electrical resistance. When they approach the earth they will enter a magnetic field, and they will cut the lines of force of this field at a high velocity. A high electrical potential will be generated, and consequently electric currents which will be inversely proportional to the resistance. The electrical energy thus produced will be dissipated in heat, and if of sufficient intensity will raise the meteor to incandescence. The truth or otherwise of this theory could, I believe, be calculated, as the data necessary for doing so will be at the disposal of readers of NATURE who make this branch of astronomy their study. This theory may have already been advanced, as I am not in touch with the latest developments of the science.

Coatbridge, September 5. GEORGE A. BROWN.

THE electric currents which the author of the above letter regards as possibly constituting an efficient source of the luminosity of meteors must no doubt arise, and play a certain part in the heat and light development. But the measure in which they can be supposed to contribute to it must clearly be extremely small; or rather, it must be incomparably subordinate to the intense ignition of the air produced, not at all by friction,[1] but by the air's adiabatic compression against the front surface of the meteorite; which is certainly quite competent, by itself alone, to develop what may be said to approach pretty nearly to fabulous degrees of temperature. If the kinetic energy of translation, in foot-pounds ($v^2/2g$), of 1 lb. of the air propelled (at, say, 30 miles per second) with the meteor's speed (v feet/sec.) on its front face, be divided by 330, the number thus obtained (1,180,620° C., in the case supposed) will be the number of centigrade degrees through which it will be heated by the pure process of compression, supposing that the air can continue to subsist at all with its ordinary mechanical deportment and thermodynamical properties unaffected at that enormously high temperature. In the further forward, gradually advancing layers, and in the laterally escaping currents of the air, on which the high forward speed of the meteor is only partially impressed, and which move more slowly on their various courses, the compressions are correspondingly less, and the lower but still exceedingly high temperatures can be similarly calculated from any fair estimates of the air's collective or absolute velocity of translation in those different positions.

It is in the different rates of transport of these heated air-streams, all of them, as well as the highly attenuated motionless atmosphere around, affording very easy passage-ways to electricity, across the earth's magnetic field or system of lines of magnetic force, that fitting circuits can certainly be found (either passing through, or else entirely omitting the meteorite itself), in which, in the way suggested in the above letter, electric currents may be quite certainly concluded to be magneto-electrically induced. For while one part of a closed air-circuit resting against the meteorite's front surface, and another part of it situated in the still atmosphere in front of or behind it, would be journeying towards or from each other with full meteor-speed, the circuits so composed would be most suitably conditioned for developing induced currents round them by

[1] Although a very general belief, it is as yet an entirely mistaken supposition that the high speed of impact of a meteorite into the rarer regions of the atmosphere reduces the air, by giving it no time to dissipate itself in front of the meteorite, to a state of granulation, or to a wedged throng of molecules producing heat by friction *inter se* and against the surface of the meteorite. Just the reverse of this condition is, however, really true, that the air remains a perfectly and frictionlessly elastic fluid, however much it is compressed and intensely heated by the impact. The speeds of sound-waves in the heated air which perform the office of transmitting and maintaining the orderly array of pressures in the streaming flows, at length differ in defect, in fact, from the air's speeds themselves in proportions which, as those mount up to meteor-speeds of many miles per second, only decline asymptotically to about the ratio $1:\sqrt{5}$, or nearly $1:2\frac{1}{4}$. Since, then, these sound-waves, which convey the strokes and shocks of the collision to and fro between the meteor-centre and the surrounding air, arise and travel in the moving field of the compressed air as if it were at rest, it is easy to perceive that by their extremely rapid actions a most exceptionally perfect elastic-fluid relation, or steady disposition of the lines, or lanes of air-flow and blast-pressure, must really be established and maintained in evenly persistent shapes and contour, in the swirl of incandescent air which forms the meteor's head.

their quickly altering enclosures of a constantly changing number of the earth's lines of magnetic force, while thus rapidly opening out or closing up. But the very short extent, not probably much exceeding some few feet or yards, which the swiftest moving part of such a circuit, in meteor-nuclei of various sizes, would embrace, and again the oft-proved weakness of the earth's magnetic field for exciting such induced electric currents, scarcely allow us to expect that any very high voltages would be attained in even the most select cases and the most favourable choices of conditions of such meteoritically produced air-circuits. The hottest, and therefore also probably the best conducting portion of each current's path, compressed against the meteorite's front surface, would also not, presumably, be that in which the heat and light producing action of the current would be strongest, since this would rather be used up in producing brush and glow discharges through the more resisting portion of the circuit in the outer air. The interior parts themselves of stony meteorites, when they have fallen, have not been found, by either sight or touch, to furnish any proofs of having been much heated, but intense effects of heat and fusion on the outer surfaces of fallen meteorites are always very obvious.

While nothing seems to point to any very easily discernible actions of electric currents immediately around a meteor's head, unless we may ascribe to electric agency the occasional production of an "aura" of sparks, or of a misty envelope of light enshrouding it, the stream of heated dust and vapours which travel in a meteor's wake, extending to considerable widths and lengths, as may be often noted, is perhaps a more visibly displayed, and a more evidently and distinctly active scene of luminous discharges of induced electric currents: for the accumulated flow behind the meteor-head resembles in some degree a columnar, vaporous follower of the meteorite itself, left to pursue its course along the meteor-track when the nucleus has disappeared. Being thus virtually a shooting-star of a long-extended shape, but of too dwarfed velocity to raise itself by heat to incandescence, the same induced electric currents as were above inferred to be developed in the meteor's head would here continue to evince themselves along the column by glow discharges in the vapours and the outer air, so long as sufficiently swift flow of the vapours can be persistently maintained through the retarding resistances of the opposing atmosphere. Thus a fairly intelligible *raison d'être* by electric current interventions may not impossibly have been incidentally divulged, by means of the recourse proposed by Mr. Brown to magneto-electric actions, of the long-enduring light-streaks left along the paths of all the swifter class of shooting-stars and larger meteors; the real *modus operandi* of those streaks having always presented to meteor observers a mysterious question for discussion, never admitting hitherto of satisfactory solution by known experimental illustrations, or of any quite surely sound elucidation by less trustworthy conjectures.

A. S. H.

A Rare Game Bird.

I THINK it is worth recording that on Thursday, October 5, Sub-Lieut. H. R. Sawbridge, R.N., shot a quail, *Perdix coturnix*, on Lopham Fen, close to the rising of the waters, the common source of the Waveney and the Ouse, near Diss, Norfolk.

The bird, either a hen or a young male, was very fat—a beautiful little specimen.

The last quail known (by me) to have been shot in this neighbourhood was in the 'fifties of the last century, by Mr. Henry Button, of this parish.

I understand that this bird was much more frequently found in the middle of last century in the neighbourhood of Great Yarmouth, and that, as a rule, it was found singly, as this was, in the autumn.

It is being preserved by Mr. Cole, of Norwich. What was a little foreign bird like this doing singly and alone on our eastern counties' heaths and fens?

Is it a case of lost or strayed, or what is it?

It would be interesting to know whether other specimens of the quail have been heard of inland in the eastern counties of late years.

JOHN S. SAWBRIDGE.

Thelnetham Rectory, Diss, Norfolk, October 16.

PHYSICAL LABORATORIES IN GERMANY.[1]

THE Director-General of Education in India has just published a valuable work in a report by Prof. Küchler, of the Presidency College, Calcutta, on physical laboratories in Germany. It forms one of a number to be included in a volume of the series of occasional reports.

Prof. Küchler "was placed on special duty to inquire into (1) the methods adopted at the universities and polytechnics of Berlin, Munich, Vienna, and other prominent universities and technical institutions in Germany with regard both to the ordinary study of physical science and to the character of the investigations and the system pursued in the case of students who are entering upon a course of independent research. (2) The construction and equipment of modern German laboratories, the special merits of scientific instruments of German manufacture, and the facilities for standardising these instruments which are offered at central institutions in Germany."

In the course of his tour, lasting more than six weeks, the principal universities and technical schools were visited, and the report sums up the information in a useful manner. It is naturally divided into two sections corresponding to the two parts of the reference; the first deals with the methods of study, the second treats of the construction, methods of equipment, &c., of the laboratories. The training of the university undergraduate of necessity differs from that of the pupil of the high school, and both methods are described at some length. Attention is directed to the importance of the set lecture in the scheme of education; the number of lectures given during the session in a university such as Berlin is very considerable, and each lecturer has the use of a properly equipped lecture-room and apparatus. The importance of the organised teaching of practical physics, for medical students, chemists, and engineers, in addition to the professed physicist, is now realised in Germany, and in an appendix, which, however, is not printed in the report, details of the practical instruction at some of the universities and technical colleges are given. In view of the large number of students in some of the German universities, the numbers attending practical classes, as given on p. 7, seem small. At Berlin there are 140 students in two divisions, each under three assistants. The average number of students in the charge of a single assistant comes to twenty-two or twenty-three, which is probably about the same as in one of our well organised English courses.

Students who propose to take a degree in physics work usually for two years at a dissertation. Prof. Küchler specially directs attention to the fact "that students are discouraged from commencing the final stages of their labours before they have been thoroughly trained in practical manipulation and have carefully gone through a complete course of laboratory work such as is represented, say, by Kohlrausch's very elaborate handbook." This fact is sometimes conveniently forgotten by those who urge the adoption of the introduction of research work at an earlier stage in our English training; the average number of these research students is said to be five or six, though, of course, at Berlin, as indeed at Cambridge, the number is much larger.

To illustrate the construction and equipment of the laboratories, Prof. Küchler has given in full the plans of a number of representative institutions, and these plans form a most valuable part of the report. They will enable a professor building or organising a

[1] A Report to the Director-General of Education in India by Prof. G. W. Küchler.

laboratory in India to see readily the arrangements which have commended themselves in Germany, and the report directs attention to the modifications which will be needed to adapt them to Indian conditions.

Perhaps the details which strike an English student most are the number and size of the lecture-rooms, the accommodation provided for the museum, and the absence of rooms specially designed for elementary classes of large numbers.

The Director-General deserves the gratitude of all interested in the organisation of the teaching of physics for having initiated this work, and Prof. Küchler is to be congratulated on the manner he has carried out his task. Still, a companion volume is needed.

British physical laboratories of to-day have many admirable points. A book that described the new laboratories at Liverpool, Manchester, the Royal College of Science, and the McGill University at Montreal, to say nothing of the historic laboratories in our two ancient universities, would contain much to interest those inhabitants of India to whom Prof. Küchler's report appeals, while in many respects, specially, perhaps, in the organisation of the practical work for large classes, the arrangements in the English laboratories seem to have the advantage.

In dealing with the last part of his subject, the construction and standardisation of instruments, Prof. Küchler again rightly directs attention to the important services rendered to German industry by the Reichsanstalt and the disadvantages under which English manufacturers find themselves from the incomplete equipment of the National Physical Laboratory.

THE ESSEX FIELD CLUB.[1]

IN order to mark the completion of a quarter of a century's scientific work in the county of Essex, the above society has published the first issue of a "Yearbook and Calendar" which will be found of interest to all who follow the work of our local scientific societies. This extremely active association was founded in 1880 by Mr. William Cole, the first president being Prof. Meldola. The work of the club has been noticed from time to time in our columns, and the present "Yearbook" contains, as an appropriate opening chapter, a history of the society by Mr. Miller Christy, who is now president. That the club has carried out the objects for which it was founded, and that it has more than justified its existence, is made perfectly clear in this introductory chapter. As the author says, "there is in Essex no other organised scientific body having the same or similar aims."

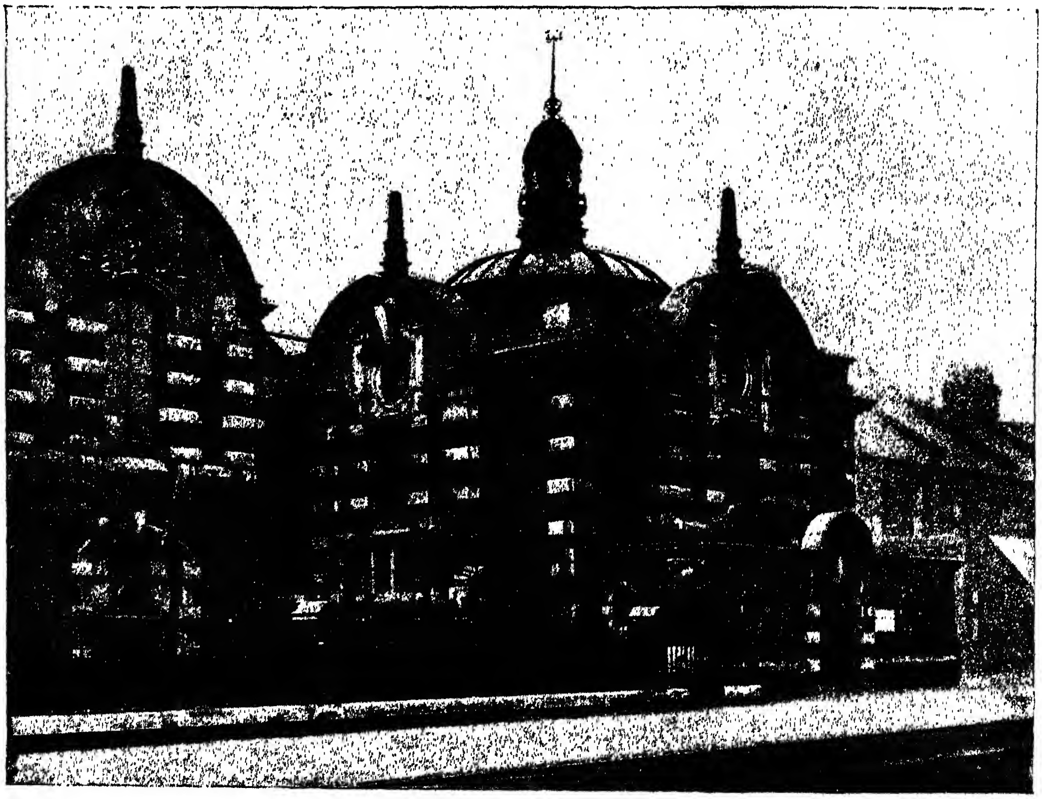

FIG. 1.—The Essex Museum of Natural History, Romford Road, Stratford, Essex.

The actual scientific achievements of the club were fully set forth in an address delivered by Prof. Meldola at the annual meeting in 1901.[2] As regards publications, the output has been not only large in quantity, but, what is more to the point, excellent in quality and strictly appropriate to the functions of a local society. Five volumes of *Transactions and Proceedings* were published down to 1887, after which the official publication was named the *Essex Naturalist*. The fourteenth volume of the latter is

[1] "Yearbook and Calendar for 1905–6." Edited by William Cole. (The Club's Headquarters, and Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 1s.

[2] "The Coming of Age of the Essex Field Club" (1901) Copies can be obtained on application to the Hon. Librarian, Mr. T. W. Reader, Essex Museum, Romford Road, Stratford, Essex.

now in course of publication. In addition to the above periodicals, three "special memoirs" have also been issued, and it is hoped that others will be added from time to time. In 1885 appeared Prof. Meldola's and Mr. White's "Report on the East Anglian Earthquake of 1884," in 1890 Mr. Miller Christy's "Birds of Essex," and in 1898 Mr. Henry Laver's "Mammals, Reptiles and Fishes of Essex." All these works were noticed in our pages at the time of publication. Four "museum handbooks" must also be credited to the club.

Not the least important part of the results achieved since 1880 is the establishment and maintenance of two museums, one of a strictly local character for the Epping Forest district at Queen Elizabeth's Lodge, Chingford, and the other of a county and educational character at West Ham in connection with, and attached to, the Municipal Technical Institute (see illustration). The first of these is carried on under an agreement with the Corporation of London, as conservators of Epping Forest. The other (county) museum was founded for the club by Mr. Passmore Edwards, and is maintained by the Borough Council of West Ham and the Essex Field Club, the library and headquarters of which are now in this same building. The *personnel* of the club as narrated by Mr. Christy is also of interest. The presidency has been held in succession by Prof. Meldola, Prof. Boulger, Mr. T. V. Holmes, Mr. E. A. Fitch, Mr. H. Laver, Mr. F. Chancellor, Mr. David Howard, Prof. Meldola, Mr. F. W. Rudler, and Mr. Miller Christy. All these are still living and active supporters of the club, while Mr. William Cole has acted as hon. secretary, editor of the publications, and curator of the museums during the whole twenty-five years of the society's existence.

There are few, if any, local societies in this country which can show such a good record. The Essex Field Club has earned the gratitude, not only of its own county, but of the world of field naturalists generally for the splendid example which it has set in showing how such organisations can keep alive the spirit of scientific research in the rural districts. In congratulating the club on its past achievements, we feel sure that the wish that its future work may be carried on with equal success will be cordially endorsed by all readers of NATURE.

THE MOSQUITOES OF PARÁ.[1]

IN 1859, when H. W. Bates returned from Pará, the town, though rapidly improving even then, was still a little-known Brazilian port, and Bates embarked on a North American trading vessel, "the United States route being the quickest as well as the pleasantest way of reaching England." At present, however, Pará is a very important place, and well up to date in scientific matters—if we may judge by the handsome publication before us, on one of the more recent branches of scientific inquiry—the transmission of yellow fever and other diseases by means of mosquitoes.

Four essays are included in the present volume, the first dealing with the mosquitoes of Pará regarded as a public calamity. This section is devoted to an historical sketch of the subject, the biology of mosquitoes, the views of various writers on the sanitary importance of the subject, and on the urgent need of practical efforts to abate the evil.

[1] "Memorias do Museu Goeldi (Museu Paraense) de Historia Natural e Ethnographia." IV. Os Mosquitos no Pará. Reunião de quatro trabalhos sobre os Mosquitos indigenas, principalmente as especies que molestam o homem. By Prof. Dr. Emilio Augusto Goeldi. With 100 figures in text and 5 chromo-lithographic plates. Pp. 154. (Pará, Brazil: C. Wiegandt, 1905.)

The second essay contains an abstract of the results of experiments undertaken in 1903, with special reference to *Stegomyia fasciata* and *Culex fatigans*, regarded from a sanitary point of view.

The third essay is devoted to biological details chiefly relating to the development of the principal indigenous species.

The fourth essay consists of a report on *Stegomyia*

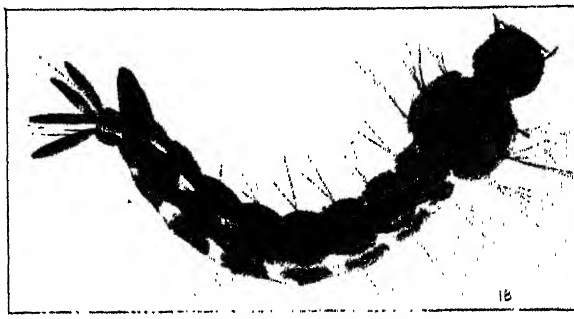

FIG. 1.—Larva of *Stegomyia fasciata*.

fasciata and its connection with the transmission of yellow fever. This was presented to the International Zoological Congress at Berne in August, 1904.

The book appears to be an extremely careful and valuable piece of work, and the paper, printing, and illustrations leave little or nothing to be desired. It must not be overlooked by any worker who is interested in mosquitoes either from a scientific or

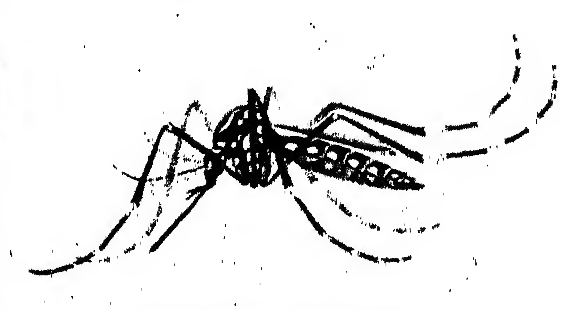

FIG. 2.—*Stegomyia fasciata* ♀ at rest.

from a medical point of view. Several new forms are described; and on p. 73 even the musical note of *Stegomyia fasciata* is discussed—a slight but significant illustration of the intimate connection and interdependence of all branches of human knowledge.

The figures which we have selected for reproduction represent the larva and imago of *Stegomyia fasciata*. W. F. K.

NOTES.

IN connection with the Conservatoire des Arts et Métiers, a museum of industrial hygiene will be opened this month at Paris by the President of the Republic.

PRINCE SERGE TROUBETZKOI, Rector of the University of Moscow, and professor of philosophy in that university, died at St. Petersburg on October 12.

THE death is announced of Mr. A. C. Pass, one of the early and most enthusiastic members of the Bristol Naturalists' Society, and for many years president of the geological section of the society.

A VIOLENT shock of earthquake occurred at Monteleone at 3.40 p.m. on October 14. The shock was felt at Messina at 3.42 p.m.; and a shock is reported to have occurred at Reggio di Calabria at 2.45 p.m.

WE learn from the *Times* that the Royal Prussian Aëronautic Observatory, recently completed, was opened on Monday, October 16, at Lindenberg, in the province of Brandenburg, in the presence of the Emperor William and the Prince of Monaco. The Emperor, in a speech, eulogised the many services rendered by the Prince of Monaco to science, and conferred upon him the large golden medal for science.

THE post-graduate college, West London Hospital, was opened on October 12 with an introductory address by Mr. Tweedy, the president of the Royal College of Surgeons, who emphasised the need for post-graduate training in medicine, and suggested that a post-graduate course should be made compulsory after a certain period in a man's career.

MR. WYNDHAM, M.P., was present at the annual conversazione of the Chester Society of National Science and Literature on October 12, and delivered an address. He accompanied Lady Grosvenor, who made a presentation to Mr. Robert Newstead, formerly curator of the Grosvenor Museum and now attached to the Liverpool School of Tropical Medicine. The gift consisted of a life-size carbon portrait of himself and a purse of more than two hundred guineas. Lady Grosvenor also presented the Kingsley medal to Dr. C. Theodore Green.

AN interesting account is given in the *Times* (October 10) of the cancer department and cancer research at the Middlesex Hospital. Since 1792 the hospital has maintained a separate cancer department by an endowment which first came through John Howard from Samuel Whitbread. The cancer wards, which now contain forty-nine beds, combine the functions of an almshouse or asylum with those of a hospital, for, in accordance with the purpose of the original foundation, the stay of patients is not limited. Howard also contemplated new discoveries from the investigation of a large number of patients and from the accumulated records of these.

THE programme of the London Institution for the session 1905–6 includes the following lectures among others:—The origin of the elephant, Prof. E. Ray Lankester, F.R.S.; submarines, Sir W. H. White, K.C.B., F.R.S.; geographical botany interpreted by direct response to the conditions of life, Rev. George Henslow; the Upper Nile, Sir Charles Eliot, K.C.M.G.; variation in man and woman, Prof. Karl Pearson, F.R.S.; our atmosphere and its wonders, Prof. Vivian B. Lewes.

THE Sociological Society has now issued its programme of meetings arranged for the winter session, along with a list of papers to be delivered before its affiliated societies in the universities of Oxford and Manchester. It is noticeable that a new departure has been made by the Sociological Society in the holding of research meetings (at which papers of interest to specialists only will be read and discussed) in addition to its ordinary monthly meetings for the reading and discussion of papers of general interest. The following papers have been arranged for the ordinary monthly meetings:—The biological foundations of sociology, Dr. Archdall Reid; the origin and function of religion, Mr. A. E. Crawley; and the Institut de Sociologie, its equipment and work, M. Waxweiler. The papers to be delivered at the research meetings are:—The study of the individual, Dr. J. L. Tayler; and biological methods in application to social problems, M. Waxweiler.

AN address of considerable importance from the standpoint of the connection between scientific training and industrial development was recently delivered by Mr. W. Burton on the occasion of the prize distribution to students of the county pottery classes at Tunstall, Staffordshire. At the outset Mr. Burton emphasised the fact that manufacturers in Staffordshire are beginning to realise the value of technical schools as a means of training students to be of real service to them. But, looking backwards, few industries in this country have during the past thirty years drawn so little aid from the resources of science as the pottery industry. The methods employed in pottery at the present day do not differ very greatly from those in use at the time of Josiah Wedgwood. But in science there has been an almost phenomenal advance since the early discoveries of Priestley, the contemporary and friend of Wedgwood. In taking up the study of pottery to-day, the student has to commence for himself almost entirely from the beginning; there is no accumulated store of knowledge and experience, such as exists in all branches of science, from which he may draw. The supreme gift of scientific training in method, Mr. Burton continues, is the power to see. "How many problems are there that present themselves to us every day in our businesses that really disappear—are no longer problems—if we once see them clearly?" The commercial organiser of a business has two problems always facing him, first the economic production of his goods, and secondly the disposal of these goods in the market. A scientific training, in so far as it gives knowledge tending to the solution of these problems, is of direct value to the commercial side of business; many problems can be solved only by scientific methods. But, Mr. Burton urges in conclusion, manufacturers should not look for too immediate results from the employment of a scientifically trained man. "Remember, he must have time to apply his science to your industry. He must have time for experiment, and must be given both leisure and the fullest opportunity to follow out those lines of prolonged and systematic investigation on which alone scientific knowledge has been built."

THE September issue of the *Proceedings of the Philadelphia Academy* contains the first portion of a long paper by Mr. C. S. Sargent on the species of thorns of the genus Cratægus found in eastern Pennsylvania, mainly based on collections and notes made by several local botanists.

THE *Irish Naturalist* for October opens with an illustrated paper by that enthusiastic ornithologist Mr. E. Williams on the recent occurrence in Ireland of a number of specimens of the Greenland and Iceland falcons, more especially the former. Previous records of the occurrence in Ireland of the Greenland falcon included nineteen instances, now raised to twenty-eight by the occurrence of no less than nine examples during the present year. On the other hand, only two previous records of the occurrence of the Iceland falcon were known, this number being raised to three by the capture of an immature female in Galway in March. The author speculates why the Iceland falcon should be so much more rare in Ireland than the far more distant Greenland species.

THE *Halifax Courier* of September 30 contains a full report of a long paper, read at the first meeting for the present session of the Halifax Scientific Society, on the educational value of the Bankfield Museum, by Mr. L.

Roth, the hon. curator. This institution, which is under the control of the Halifax municipality, is devoted to art, local history, numismatics, and ethnology, and it has been the object of the present curator during his whole term of office to make these collections thoroughly representative and of real educational value. Consequently he has rigorously excluded from the exhibition cases all specimens coming merely under the designation of "curios," and devoid of special local or educational interest—an example which might, by the way, be followed by the authorities of at least one rate-supported local museum we could name. Whether this rigid censorship has aroused ill-feeling we cannot say, but at the conclusion of his address Mr. Roth referred in somewhat bitter terms to the apathy displayed by the municipal authorities towards his efforts. Certainly thirty-six guineas a year is not a lavish sum for the needs of such a museum, and the committee appear to have funds at their disposal which they refuse to spend.

No. 13 B. of the *Publications de Circonstance*, recently issued in Copenhagen by the International Council for the Study of the Sea, contains an account of the present condition of the German fisheries in the Baltic, and is a continuation of the publication already issued (No. 13 A) on the Danish and Swedish fisheries in that sea. The present work has been prepared for the German Sea-Fisheries Association by Dr. E. Fischer in cooperation with Prof. H. Henking. It gives in a concise form information as to the different kinds of fishing practised in the area, as well as an account of the boats, nets, and other fishing gear employed, and of the quantities and values of the fish landed. The fluctuations of the various fisheries from year to year for the last ten years are shown in a series of tables and curves, and a number of lithographed charts illustrate the relative local abundance of different species of fish along the German coasts of the Baltic.

THE second part of the first volume of the useful little flora of the upper Gangetic plain, by Mr. J. F. Duthie, has been published recently; it includes the orders Caprifoliaceæ to Campanulaceæ, and the index to the volume.

THE late Prof. L. Errera showed a marked preference for physiological problems, and one of his last papers, which is published in vol. xlii. of the *Bulletin de la Société royale de botanique de Belge*, takes up the difficult subject of the ultimate cause behind reaction in plants. The paper deals with dominance and inhibitory action, as exemplified in the correlation existing between the directions assumed by the main vertical shoot of a tree and its branches under the influence of geotropic stimulus. Nutrition or polarity has generally been invoked to furnish an explanation, but Prof. Errera argues in favour of inhibiting action, possibly due to internal secretions.

REPORTS for 1904–5 on the botanic stations at Antigua and St. Kitts have been received. Owing to the want of uniformity in the amount of *fuzz* on the cotton seed imported from the Sea Islands into Antigua, some doubt was expressed as to its purity. To test the matter some of the seed was graded, and each grade was sown on a separate plot; however, on reaping the cotton, the lint from the different plots did not present any marked difference, and the seed was no more uniform than before. The conclusion is drawn that the character of the lint is fixed, and does not alter with variations in the character of the seed. In St. Kitts and Nevis interest attaches to the cacao and rubber plantations which have been recently started; the rubber plants consist of Castilloa and Funtumia. The work at the agricultural school in St. Kitts is worthy of mention; the practical course includes the cultivation of vegetables, the application of manures to pine and cotton crops, and the propagation of plants by budding and cuttings.

WE have received from the Minister of the Interior the twenty-fourth Bulletin issued by the Peruvian Corps of Mining Engineers. It contains the mineral statistics of Peru for 1904. The production in that year included 59,920 tons of coal, 38,683 tons of petroleum, 2209 tons of lead, 9503 tons of copper, 2675 tons of borates, 18,544 tons of rock salt, 21 tons of sulphur, 145,165 kilograms of silver, and 601 kilograms of gold. Compared with the production in the previous year, noteworthy increases are shown.

THE interesting paper on some phenomena of permanent deformation in metals read by Mr. G. H. Gulliver, of Edinburgh University, before the Institution of Mechanical Engineers in February has now been published in pamphlet form. In making a tension test of a metal bar as soon as the yield-point is reached, the deformation becomes visible to the naked eye as the well known Lüder's lines. Hitherto the lines occurring at the yield-point have been confused with the two straight depressions known as the "contractile cross." The author shows that the two phenomena are quite distinct. In his experiments flat steel bars were used $\frac{1}{8}$ inch in thickness and of various widths from $\frac{1}{2}$ inch to 4 inches.

THE second part of the mines and quarries general report for 1904 has been issued by the Home Office. It contains statistics of the persons employed and of the accidents that occurred. The total number of persons employed at mines and quarries in the United Kingdom and in the Isle of Man in 1904 was 974,634, of whom 877,057 were employed at mines. The death rate from accidents was 1·243 per 1000 persons employed at mines and 1·15 per 1000 at quarries. By the Act of 1903, the value of scientific training in mining is now shown to be appreciated by the Government, the holders of diplomas at institutions approved by the Secretary of State for the Home Department being eligible for managers' certificates after three years' practical experience instead of five as was formerly the case. The list of institutions that have been approved is given in the report, and comprises the Royal School of Mines, the universities of Birmingham, Cambridge, Durham, Glasgow, Leeds, London, Oxford, Sheffield and Wales, the University College, Bristol, the Glasgow Technical College, and the Wigan Mining College.

IN the *American Journal of Science* (vol. xx., No. 118) Mr. Bertram B. Boltwood quotes a number of analyses of minerals containing uranium and thorium, and interprets them by assuming that the ultimate disintegration products of the radio-active elements may include lead, barium, bismuth, the rare earths, argon, and hydrogen. The question is raised whether the quantities of these elements actually existing in nature have not been produced wholly by some such process of disintegration.

IN the *Atti dei Lincei* (vol. xiv. p. 188) B. Gosio describes how the decomposition of exceedingly dilute solutions of alkaline selenites, or, better, of alkaline tellurites, may be utilised as a delicate test for living bacterial contamination. Most living bacteria are capable of decomposing potassium tellurite with the production of a blackish precipitate, becoming themselves, when viewed under the microscope, tinged blackish grey. Dead bac-

teria or spores not undergoing actual development are totally without action on a solution of the tellurite. The test seems to be especially useful for ensuring sterility in the case of liquids or therapeutic sera destined for hypodermic injection.

THE many thermoelectric methods which have been devised during the past few years for the measurement of very high and of very low temperatures have proved themselves of a wide and general utility. But hitherto no instrument of a similar type has been made available for the accurate measurement of temperatures between 0° C. and 200° C. In the *Physical Review* (vol. xxi. p. 65) Mr. A. de Forest Palmer describes a thermojunction consisting of a soft iron wire in conjunction with an "advance" wire containing copper, nickel, and iron, by means of which temperatures within the extremes named may be determined with an error not exceeding 0·04 per cent. Such an instrument is easily calibrated, and in certain circumstances can profitably replace a mercury thermometer of a corresponding degree of accuracy.

Le Radium for September (2e année, No. 9) contains articles on the influence of the connections on the action of vacuum tubes, by M. Charbonneau, on the treatment of cancer with radium, by M. Darier, and a summary of current work connected with radio-activity.

THE *Journal of the Royal Sanitary Institute* for October (xxvi., No. 9) contains articles on the administration of the Food and Drugs Act, by Mr. Wellesley Harris, on the waste of infant life, by Dr. Nash, on hygiene in education, by Mr. White Wallis, and notes on common parasites found in bodies of animals used for food, by Mr. King.

WE have received "Contributions from the Research Laboratory and Sewage Experimental Station," Massachusetts Institute of Technology, Boston, vol. i., 1905. It contains several valuable papers, *e.g.* the mode of action of the contact filter in sewage purification, by Messrs. Phelps and Farrell, determination of organic nitrogen in sewage by the Kjeldahl process, by Mr. Phelps, a study of the methods in current use for the determination of free and albumenoid ammonia in sewage, by Mr. Phelps, and determination of the number of bacteria in sewage, &c., by Mr. Winslow.

MESSRS. F. VIEWEG AND SON, Brunswick, have published a fourth edition of "Hauptsätze der Differential- und Integral-rechnung," by Prof. R. Fricke.

MR. W. B. CLIVE has published a third edition of Dr. G. H. Bailey's "Second Stage Inorganic Chemistry (Theoretical)." This edition has been re-written and enlarged.

THE third, revised edition of "Leitfaden für das zoologische Praktikum," by Prof. W. Kükenthal, has been published by Mr. Gustav Fischer, Jena. The second edition of this work was reviewed in NATURE of April 24, 1902 (vol. lxv. p. 581).

THE first part of a work on "Die ätherischen Öle," by Dr. F. W. Semmler, has just been received from the publishers, Messrs. Veit and Co., Leipzig. It is proposed to issue the work in twelve parts which will make up three volumes, to be completed during next year. The work will be noticed when the whole of the parts have been received.

A THIRD edition of Mr. Tyson Sewell's "Elements of Electrical Engineering" has been published by Messrs. Crosby Lockwood and Son. The book was reviewed in NATURE of November 20, 1902 (vol. lxvii. p. 53), and it is only necessary to mention that more examples have been added to the appendix, and that particulars of the "Wright" and other electrolytic meters have been inserted.

A SECOND edition of Mr. J. W. Russell's "Elementary Treatise on Pure Geometry" has been published by the Clarendon Press. The first edition of the book was noticed in our issue of June 1, 1893 (vol. xlviii. p. 101). Besides numerous small improvements throughout, other changes have been made in the revised edition, and among these may be mentioned the re-arrangement of the examples and the omission of redundant ones. Each chapter has been made independent of following chapters; more use has been made of projection in proofs of theorems, and correlative theorems have been proved by reciprocation. An index has been added.

MESSRS. FLATTERS AND GARNETT, LTD., Deansgate, Manchester, have sent us a specimen of new storage cabinets made by them for lantern slides. Each drawer of the cabinet will hold 100 slides in five divisions, and is fitted with brass handle and space for movable card label. Single drawers are supplied, and cabinets are made with four, six, twelve, and twenty-four drawers. There are no grooves in the drawers, but the top edges are cut down a little, so that the slides rise above the edges and can readily be lifted out. The cabinets provide a convenient and neat means of storing lantern slides. A despatch box also submitted by Messrs. Flatters and Garnett is fitted at each end with a strip of brass which clasps the cover when the slides are in transit, and can be swung off immediately the slides are required. This box has the usual rubber packing to prevent shock and breakage.

OUR ASTRONOMICAL COLUMN.

ANOTHER LARGE SUN-SPOT.—Another large group of sunspots, the fourth or fifth this year to be visible to the protected naked-eye, is now to be seen on the solar disc not very far from the centre. The group, which consists of a large number of separate small nuclei, is, roughly, 100,000 miles across its longest diameter, and was first seen coming round the limb on Saturday, October 14.

M. BIGOURDAN'S ECLIPSE RESULTS.—M. Bigourdan, who was placed in charge of the Bureau des Longitudes expedition to Sfax (Tunis) to observe the recent total eclipse of the sun, communicated the preliminary results of his observations to a meeting of the Paris Academy of Sciences held on October 2. The greater part of his communication consisted of descriptions of the instruments employed and the conditions they were employed under.

A coronagraph, designed to take numerous large-scale photographs, in order to show the relation between the details of the inner corona and those on the corresponding regions of the solar disc, became deranged after the second plate was exposed, but the two plates obtained show numerous details of the inner corona. In a second coronagraph, of 0·95 m. focal length and 0·15 m. aperture, a green glass screen, transmitting only those wave-lengths near to λ 530, was placed in front of the plate, and the exposure made to last throughout totality. The negative obtained shows the corona extending for about 30′ from the moon's limb.

Two spectroscopes having slits much longer than the diameter of the solar image were employed, the slits being so arranged that the spectrum of the coronal radiations at points situated at the ends of the sun's axis and equator respectively might be photographed. Photometric observations of the corona, both visual and photographic, were also made.

Observations of the terrestrial magnetic elements showed that the variations caused by the interposition of the moon were but small. The shadow bands formed a very striking

feature of this eclipse, and were recorded by many observers at Sfax as being sinuous, undulating, and nearly parallel. They travelled at a rate equal to the average walking pace of a man (*Comptes rendus*, No. 14).

ATMOSPHERIC ORIGIN OF "SHADOW BANDS."—In No. 4049 of the *Astronomische Nachrichten* Signor T. Zona, of Palermo, suggests that the shadow bands observed during a total eclipse of the sun are of a purely atmospheric origin. He has observed that the rays of light projected from a man-of-war's searchlight on to a wall several kilometres from the ship exhibit just the same kind of light and dark bands that he observed at Sfax during the recent solar eclipse.

Similarly, he noticed that the light from Venus projected through a small window on to the opposite wall of the room in which he was seated exhibited the same appearance.

Signor Zona suggests that the atmospheric vibrations which cause the agitation seen at the sun's limb, when the latter is observed directly, are the cause of the oscillating bands seen during total eclipses.

A SPECTROGRAPHIC DETERMINATION OF THE SOLAR PARALLAX.—In Nos. 4048–9 of the *Astronomische Nachrichten* Herr F. Küstner describes in detail a method which he has employed to determine the sun's parallax spectrographically, from measurements of sixteen lines on each of eighteen spectrograms of Arcturus, obtained during the period June 24, 1904–January 15, 1905, with the Bonn spectrograph. From these measurements he found the radial velocity of Arcturus relative to the sun to be -4.83 ± 0.27 km. for the epoch 1904·8, and the value for the mean velocity of the earth to be 29.617 ± 0.057 km., the accepted value for the velocity of light *in vacuo* being 299865 ± 26 km. per second.

As the solar parallax previously accepted, viz. 8″·800, is based on the assumption that the earth's velocity is 29·765 km., and as these two quantities vary proportionally, it follows that with a more correct value for the latter a more refined value for the former may be determined.

Having made the determination, Herr Küstner arrives at the quantity $8''.844 \pm 0''.017$ as his final result for the value of the solar parallax.

NOVA AQUILÆ NO. 2.—The results of several recent observations of the Fleming Nova are published in No. 4049 of the *Astronomische Nachrichten*.

Prof. Wolf, observing on September 17 at 8h. 4·3m. (Konigstühl M.T.), found the Nova's magnitude to be 9·6, showing a decrease of not quite 0·3 mag. since September 4.

Dr. Guthnick, observing at Bothkamp, obtained the photometric results shown in the following table:—

1905	M.T. Berlin	Mag.	1905	M.T. Berlin	Mag.
Sept. 5	8 9h.	10·32	Sept. 14	8·3h.	10·47
,, 8	10·3h.	10·30	,, 19	9·2h.	10·55
,, 12	10·1h.	10·40	,, 22	9·3h.	10·66
,, 13	9 0h	10·52	,, 23	9·1h.	10·63

The magnitudes are based on those given for the comparison stars in the Harvard photometric revision of the B.D. catalogue.

LIGHT-VARIATION OF SATURN'S SATELLITES.—From observations made on twelve evenings, Dr. P. Guthnick, of Bothkamp Observatory, has determined the phases of the magnitude changes of Tethys, Dione, Rhea, and Titan.

He found that the first named is brightest when at easterly elongation (90°) and faintest at about 330°. Dione reaches its maximum brightness at 90° and its minimum at about 40°. Rhea apparently has two maxima, one at 40°–120° and a fainter one at 240°, the corresponding minima occurring at 180° and 330° respectively. The maximum brightness of Titan occurs at 240°, its minimum brightness at 20°. In regard to Japetus, Dr. Guthnick's observations confirm the results obtained by Prof. Pickering, viz. that the maximum brightness of that satellite occurs at the western, and the minimum at the eastern, elongation. The range of light-variation for each of the satellites Tethys, Dione, and Titan is about 0·75 mag., for Rhea about 1·0 mag., and for Japetus about 1·75 mag. (*Astronomische Nachrichten*, No. 4049).

INTERNATIONAL CONGRESS ON RADIOLOGY AND IONISATION.

THE first international congress for the study of radiology and ionisation, organised under the auspices of the Belgian Government, was held at Liége on September 12–14. The work of the congress was divided into two sections, devoted respectively to physical and biological science. The first section dealt with the following questions:—(1) physics of electrons, comprising also radiations of all kinds; (2) radio-activity and the accompanying transformations; (3) meteorological and astronomical phenomena attributable to ionisation, radio-activity, and to radiations of different kinds. The second section had for its scope the study of the physiological properties of the radiations and their application in medicine.

The opening session of the congress was held in the physics theatre of the University of Liége on September 12, under the presidency of Prof. Kuborn, member of the Royal Belgian Academy of Medicine. Among the members present may be named Profs. Becquerel, Bouchard, and Bergonié, representing the French Republic, Señor J. Muñoz del Castillo, officially representing Spain, Drs. E. F. Nichols and W. Dieffenbach (United States), Prof. Hurmuzescu (Roumania), Prof. Gillon (Italy), Dr. Yankorits (Servia), Lion Sy Thang (China), Dr. Arrago (Guatemala), Dr. Ortiz (Argentine). Prof. Lassar represented the Röntgen Association of Berlin, Prof. Onnen the Royal Society of Batavia, and Mr. Wilton the University of Adelaide, South Australia. The following were also present:—Messrs. Birkeland, Himstedt (Freiburg in B.), Gariel (Paris), and Legge (London).

Sir William Ramsay had intended to present an address on radio-thorium, but in his unavoidable absence it was read on his behalf. M. Becquerel gave a lecture on the analysis of the radiations of radio-active substances. The address will be published in the *Comptes rendus* of the congress, shortly to be issued by the organising committee (general offices, No. 1 Rue de la Prévôté, Brussels).

On September 13 a general meeting was held. Prof. Wind, of Utrecht, presented a communication on the diffraction and wave-length of the *n*-rays, and demonstrated the character of the apparatus designed by his colleague M. Haga and himself for the study of this much controverted question. Prof. Lassar, of Berlin, gave an account of the practical application of the new radiations. M. Tommasina, of Geneva, described a study of the radio-activity produced by atmospheric air (Elster and Geitel's phenomenon), and papers relating to the therapeutic action of the X-rays and of radium were read by Drs. Bergonié (Bordeaux), Dieffenbach (New York), and Kassabian (Philadelphia). The latter's hands, owing to their frequent exposure to the radiations used for therapeutic treatment, have during the past few years undergone characteristic changes.

The following papers of noteworthy interest were presented at later meetings:—Remarks relative to the terminology of ionisation, Prof. de Hemptinne (Louvain); disruptive discharge in gases at high pressures, Prof. Guye (Geneva); the spectroscopic study of radium light, Prof. Himstedt (Freiburg in B.); the kinetic theory of the electron serving as a basis for the electronic theory of radiation, Dr. Tommasina (Geneva); on the radio-active constituents of sediments from Echaillon and Salins-Moutiers, Dr. Blanc (Rome); a new apparatus for determining the radio-activity of spring-waters, Dr. H. Sieveking (Karlsruhe); Moser's radiations, Prof. Piltschikoff (Kharkoff); discharge phenomena caused by X-rays and radium radiations, and the transformation of these rays, Prof. Hurmuzescu; critical observations on the theories of atomic disintegration and chemicophysical dissociation, Prof. Muñoz del Castillo; the method of transmission of excited activity to the kathode, Mr. Makower (Manchester); radio-activity of the lava from Vesuvius (eruption of 1904), Dr. Tommasina; on the change of properties of the chemical elements, Prof. Fabinyi (Kolozsvar, Hungary); (1) the experimental methods of studying the transformations of the X-rays and the secondary rays resulting therefrom, (2) classification and mechanism of the different electric phenomena caused by the X-rays, Prof. Sagnac (Paris); absorption phenomena of radium and polonium

rays, Prof. Riecke (Göttingen), paper presented by Dr. Emil Bose.

Limitations of space prevent the enumeration of papers not read at the congress but accepted for insertion in the *Comptes rendus*, as well as of the communications read before the biological section. The final meeting of the congress was held on September 14. After several interesting communications had been read, including one from Sir William Huggins, presented by Prof. Becquerel, the following motion was put before the meeting by the executive of the congress, acting at the wish of Prof. Jose Muñoz del Castillo:—

The International Congress for the Study of Radiology and Ionisation assembled in plenary session at Liége on September 14, 1905, considers that, although State regulation and protection may sometimes impede free research among men of science, it is, however, necessary that Governments should, without creating monopolies, be brought to apply to radio-active substances the same legislative measures that prevent the monopolisation of other useful substances, and should guarantee by the play of economic laws free scientific research and the application of these substances to the treatment of the sick; and considers also that it is desirable to be able to advise or remind the Governments of the importance of these measures and that a permanent commission invested with powers by the actual congress, an assembly of men of science devoted to the study of these questions and belonging to different countries, would carry weight in discussing with public authorities matters appertaining to the needs of science or the requirements of the sick. It has therefore decided

(1) That an international commission for examining all questions of general interest relative to radio-active substances shall be instituted.

(2) That the commission shall meet regularly each year, and may be convened on any exceptional occasion by the president, acting with the majority of the executive.

(3) That it shall organise periodically international congresses, to meet every five years, and shall also be empowered to convene the congress in extraordinary session.

(4) That the members of this commission shall be subject to re-election at each meeting of the International Congress.

THE COALFIELDS OF NORTH STAFFORDSHIRE.

THE memoir described below[1] contains detailed accounts of the coalfields of North Staffordshire, especially those of the Pottery and Cheadle Coalfields. The re-survey on the 6-inch scale was commenced in 1898 and completed in 1901. The present volume, which contains detailed descriptions furnished by each geologist of the area surveyed by himself, has been largely written and edited by Mr. Gibson, who personally carried out the greater part of the field-work. It was pointed out by Beete Jukes long ago that, so far as the higher portions of the Coal-measures were concerned, North Staffordshire provided the type development of the Midlands. Mr. Gibson has now established in that region a definite stratigraphical sequence in the comparatively barren strata which conformably overlie the productive Coal-measures, and he has also proved that the same sequence may be recognised in the other coalfields of the Midland area.

The chief points of interest are contained in chapter iv., which describes fully the determination of the Newcastle-under-Lyme group, the Etruria Marl group, and the Black Band group, and more particularly the removal of Hull's "Salopian Permian" into the Carboniferous. A full account of the palæontological and stratigraphical evidence on which this change is based is given at pp. 53 to 55. The evidence shows that the Salopian Permian of Staffordshire, Denbighshire, Worcestershire, Warwickshire, and in all probability Lancashire, occurs as the highest group of a definite sequence everywhere overlying the higher beds of the true Coal-measures, but never discordant to them, and that the Salopian Permian on either side of the Pennine Chain conforms to the Coal-measures, but is unconformably overlain on the eastern side by the Magnesian Limestone series.

It has been found advisable to adopt purely descriptive terms for various subdivisions, and for similar reasons the expressions Upper, Middle, and Lower Coal-measures have not been adopted, since the positions of the palæontological boundary lines which give a definite significance to the terms have not been determined with accuracy. Since the memoir was written, Mr. R. Kidston has contributed a paper to the Geological Society on the divisions and correlation of the upper portions of the Coal-measures, in which he proposes the name "Staffordian" for the series included between the Black Band group and the Newcastle-under-Lyme group, while the Keele group and similar beds in the Midland coalfields, hitherto referred to the Permian system, are classed with the Radstock group, previously called Upper Coal-measures. The distribution of the plants certainly favours such a classification, but there is evidence which seems to show a gradual passage of one group into another, and Dr. Hind, who has devoted considerable attention to the study of the lamellibranchs, is not in favour of the proposed subdivision.

One of the most pleasing features is the accurate and complete description of the palæontology, which is treated in detail by Mr. John Ward, and is accompanied by full lists, with six plates, of the common fossils of the Coal-measures. The Pottery Coalfield has long been recognised as an unrivalled field for the study of Carboniferous fishes, the study of which has to some extent overshadowed the examination of a numerous and varied series of molluscan remains and the equally abundant flora it has yielded. In this section Dr. W. Hind has given Mr. Ward a great deal of assistance. The fossil fishes have been named by Dr. Traquair and Dr. Smith Woodward, while the plants have been dealt with by Mr. Kidston. A complete geological bibliography of the North Staffordshire coalfields, covering fifteen pages, forms a valuable appendix.

The Triassic and Glacial deposits are described in separate chapters, and the economic products of the Pottery Coalfields are treated in chapter xii. The latter account includes the consideration of the future coal supply of the district from the concealed coalfield, to which considerable attention is paid. In addition descriptions are added of the local building stones, clays, and marls, supplemented by an enumeration of the chief source of water.

H. W. HUGHES.

1 "Memoirs of the Geological Survey of England and Wales. The North Staffordshire Coalfields." By W. Gibson. With Contributions by G. Barrow, C. B. Wedd, and J. Ward. Pp. vii+494; with 1 Coloured Map and 6 Plates. (London: Edward Stanford, 1905.) Price 6s.

THE DISTRIBUTION OF POWER.[1]

TWENTY-SIX years ago, at the meeting of the British Association at Sheffield, August, 1879, a lecture, on "Electricity as a Motive Power," was delivered to some thousands of working men, and, for the first time, they realised that forks and spoons could not only be plated with the electric current, but could also be polished with a brush made to spin with the same agency.

The sea of upturned faces beamed with delight when Jack, their popular comrade, stepped on to the platform, took the newly plated spoon in his hands, and burnished it —a pair of thin wires tied to a church steeple being the only connecting link between the dynamo machine in a neighbouring works—ordinarily used there for electro-plating—and the electro-motor driving the polishing brush in the Albert Hall, Sheffield.

But an electro-motor is only a toy, thought my audience; nobody could construct an electro-motor that we could not stop with our hands; and at the end of my lecture they actually tried, and—wondered.

As far as I am aware, it was at that lecture that the following composite suggestion was first put forward—to obtain economy in electric transmission of power the current must be kept small, while to transmit much power the electric pressure between the conducting wires must be made large; and, lastly, to secure safety and convenience

1 Lecture delivered on Tuesday, August 29, at a meeting of the British Association in Johannesburg, by Prof. W. E. Ayrton, F.R.S., and illustrated with many experiments on moving machinery, diagrams, and lantern slides, two lanterns being used, in the American fashion, for enabling pictures to be contrasted on the screen.

SUPPLEMENT TO "NATURE."

A TIBETAN DICTIONARY.

A Tibetan-English Dictionary with Sanskrit Synonyms. By Sarat Chandra Das. Revised and edited by G. Sandberg, B.A., and A. W. Heyde. Pp. xxxiv+1353. (Calcutta: Bengal Secretariat Press, 1902.)

THE chief attraction which the Tibetan language possesses for the western reader is that it is the Latin of Central Asia, and preserves in its bulky literature the old-world lore and vestiges of early culture which the priestly schoolmen of Tibet believed to be all that was worth knowing, not only about their own country, but of the outside world, and more especially ancient India, regarding which so little is known to us. For Tibet, upon receiving its Buddhism from India in the seventh century A.D., adopted at the same time the Indian characters for the purpose of reducing its hitherto unwritten Mongolian language into writing, and forthwith translated into its new vernacular the Indian Buddhist scriptures and other works, the originals of which were afterwards destroyed by the fanatical Mohammedan invaders on the expulsion of Buddhism from India in the twelfth century A.D. From these scripts, thus preserved in their Tibetan translations, much invaluable information has already been gleaned by European scholars; but owing to a habit of the learned monks to translate most of the proper names, of persons, places, and things, root by root etymologically into the Tibetan, it so happens that without a copious Tibeto-Sanskrit lexicon to re-convert these translated names into their recognisable Indian equivalents, a great deal of the mass of information locked up in the Tibetan volumes, now accumulating in our national libraries, remains to some extent sealed.

This is what the present dictionary claims to facilitate to a greater extent than has been done by the lexicons of the pioneer Csoma, the Hungarian, the scientifically equipped Moravian missionary, Jäschke, and Père Desgodins. It has been compiled by Babu Sarat Das from vernacular dictionaries brought by him from Tibet, when he visited that country some years ago. His revisers complain that they found "the material had been put together in somewhat heterogeneous fashion hardly systematic enough for a dictionary," so that they had to take "the greatest freedom in correcting or rejecting the matter set forth in the work." This task of correction has obviously not been carried far enough, for in its published form this ponderous volume still retains serious shortcomings in the elementary requirements of a dictionary. The definitions offered are too often wanting in accuracy to be trusted, or too wanting in necessary details and useful references to be very helpful. The Sanskrit synonyms are not so numerous as they might have been, and their definitions are usually made up of indiscriminate extracts from the Sanskrit-English dictionaries of English lexicographers, reproduced often without acknowledgment and with strange confusion and errors.

For instance, to refer to some of the botanical matters in the first few pages, under "Kakola," an aromatic spice, the author has taken the latter part of his definition from Wilson's dictionary without acknowledgment, and included with it part of the definition of the next following word; he also states that cardamom is "the fruit of *Cocculus indicus*," and mistakes Erandi or cubeb pepper for Erand, or the castor-oil plant. Again, "Kapi" is given in trustworthy Tibetan lexicons as the Sanskrit equivalent of "Ka*p*ittha," not "Ka*b*ittha" as stated by the Babu, and secondarily "Pithanaja," which is omitted by him. The primary meaning, therefore, is the wood-apple tree (*Feronia elephantum*) and not "resin of the juniper plant" as given by him. As secondary meanings he inserts five lines taken without acknowledgment from Wilson, and in so doing misspells each of the three botanical names, and alters "waved-leaf fig tree" into the nonsensical "manefig tree." In the next word, also, both the Sanskrit and botanical terms, taken unacknowledged from Wilson, are misspelt.

Again, "Chu-sing kar-po," or "the white water-tree," is absurdly stated by him to be *Aconitum ferox*, which, however, is black rather than white, and never called a "tree" by the Tibetans, to whom it is familiar. The vernacular lexicon, however, gives for "water-tree" the Sanskrit "Kadali," or "water-wood," which is the appropriate name of the watery plantain tree, and it gives the further synonym "Mochaka," or the "horse-radish-tree," which the Babu omits. Of this tree, the "Sajina" of Indian cooks, there are two varieties, namely, a red and a white kind, the latter of which is the one that has been wrongly identified with the deadly aconite by our compiler. Still another synonym for this word, "Nālam," a reed or "stalked water-plant," is incorrectly given as "the ratan" (*sic*); and the author frequently confuses cane with bamboo.

Not infrequently the precise shade of meaning is missed; thus *Rig-dsin*, which literally and invariably means "a holder of knowledge" or sage, is defined by him as "comprehension of a science (*sic*) with ease"; and seldom is any hint given of the useful literal meaning of such names as the common word for small-pox, which is euphemistically called "God's granules" in deference to the malignant disease spirit.

As instances of common words altogether omitted are *La-lis*, the respectful form of "yes," which after the mystic "*Om*" formula is perhaps the word most frequently uttered in Tibet; *Choma*, the common Potentilla, the root of which is eaten as a food; *pin-kyur-ma*, the kestrel, being onomatopœtic for its call; the word for "bribe," which is ethically interesting as meaning literally "a secret push."

His orthography disregards some of the accepted rules of scientific philologists, so as to give "Daipung" for the great monastery of Däpung, although no *i* occurs either in the vernacular spelling or pronunciation. We miss, too, in a dictionary of this size, which owing largely to clumsier type is

thrice the weight of Jäschke's, any illustrations of the interesting process of organic change whereby so many of the bristling consonants of the written speech have dropped out of hearing in the spoken dialects of the temperate central province, probably for physiological and climatic reasons.

Nevertheless, despite its many defects, it embodies a good deal of new material from the vernacular Tibetan lexicons which must prove suggestive to those engaged in Tibetan researches who are sufficiently advanced not to be misled by its serious mistakes.

L. A. WADDELL.

FINGER-PRINT IDENTIFICATION.

Guide to Finger-print Identification. By Henry Faulds, L.F.P.S., late Surgeon Superintendent of Tsukiji Hospital, Tokyo, Japan. Pp. viii+80. (Hanley: Wood, Mitchell and Co., Ltd., 1905.) Price 5*s*. net.

DR. FAULDS was for some years a medical officer in Japan, and a zealous and original investigator of finger-prints. He wrote an interesting letter about them in NATURE, October 28, 1880, dwelling upon the legal purposes to which they might be applied, and he appears to be the first person who published anything, *in print,* on this subject. However, his suggestions of introducing the use of finger-prints fell flat. The reason that they did not attract attention was presumably that he supported them by no convincing proofs of three elementary propositions on which the suitability of finger-prints for legal purposes depends. It was necessary to adduce strong evidence of the, long since vaguely alleged, permanence of those ridges on the bulbs of the fingers that print their distinctive lineations. It was necessary to adduce better evidence than opinions based on mere inspection, of the vast variety in the minute details of those markings, and finally, for purposes of criminal investigation, it was necessary to prove that a large collection could be classified with sufficient precision to enable the officials in charge of it to find out speedily whether a duplicate of any set of prints that might be submitted to them did or did not exist in the collection. Dr. Faulds had no part in establishing any one of these most important preliminaries.

But though his letter of 1880 was, as above mentioned, apparently the first *printed* communication on the subject, it appeared years after the first public and *official use* of finger-prints had been made by Sir William Herschel in India, to whom the credit of originality that Dr. Faulds desires to monopolise is far more justly due. Those who care to learn the facts at first hand should turn to NATURE, vol. xxii. p. 605, for Dr. Faulds's first letter, to vol. l., p. 518, for a second letter from him in reference to the Parliamentary Blue-book on the "Identification of Criminals," then just issued, and lastly to Sir Wm. Herschel's reply in vol. li., pp. 77–8, where the question of priority of dates is placed beyond doubt, by the reprint of the office copy of Sir William's "demi-official" letter of August 15, 1877, to the then Inspector of Prisons in Bengal. This letter covers all that is important in Dr. Faulds's subsequent communication in 1880, and goes considerably further. The method introduced by Sir Wm. Herschel, tentatively at first as a safeguard against personation, had gradually been developed and tested, both in the jail and in the registering office, during a period of from ten to fifteen years before 1877, as stated in the above quoted letter to the Inspector of Prisons.

The failure of Sir Wm. Herschel's successor, and of others at that time in authority in Bengal, to continue the development of the system so happily begun, is greatly to be deplored, but it can be explained on the same grounds as those mentioned above in connection with Dr. Faulds. The writer of these remarks can testify to the occasional incredulity in the early 'nineties concerning the permanence of the ridges, for it happened to himself while staying at the house of a once distinguished physiologist who was the writer when young of an article on the skin in a first-class encyclopædia, to hear strong objections made to that opinion. His theoretical grounds were that the glands, the ducts of which pierce the ridges, would multiply with the growth of the hand, and it was not until the hands of the physiologist's own children had been examined by him through a lens, that he could be convinced that the lineations on a child's hand might be the same as when he grew up, but on a smaller scale.

The literature concerning finger-prints is becoming large. An excellent index to it will be found in a memoir by Otto Schlaginhaufen, just published (*Morphol. Jahrbuch,* Bd. xxxiii., H. 4, and Bd. xxxiv., H. 1., Leipzig). But even this is incomplete, for it takes no notice of Mr. Tabor's efforts in San Francisco to obtain the official registration of the finger-prints of the Chinese immigrants, whom it was found difficult to identify otherwise. This seems to have occurred at some time in the 'eighties, possibly before them, but dates are now wanting.

Dr. Faulds in his present volume recapitulates his old grievance with no less bitterness than formerly. He overstates the value of his own work, belittles that of others, and carps at evidence recently given in criminal cases. His book is not only biased and imperfect, but unfortunately it contains nothing new that is of value, so far as the writer of these remarks can judge, and much of what Dr. Faulds seems to consider new has long since been forestalled. It is a pity that he did not avail himself of the opportunity of writing a book up to date, for he can write well, and the photographic illustrations which his publisher has supplied are excellent. The experiences of other countries ought soon to be collated with those of England, in order to develop further the art of classifying large collections of finger-prints. In Argentina, for example, their use has wholly superseded Bertillonage, and one would like to know with what success. A bureau that can deal effectively with very many thousands of cases would require a staff of particularly intelligent officials, and the tradition of dealing in the same way with certain transitional forms that are of frequent occurrence. The more highly the art of

classifying, or as it might be phrased of "lexiconising," finger-prints is developed, the more wide will their use become. They ought to be especially valuable in checking desertions from the Army and Navy. But there may be moral objections to the use of finger-prints in these cases for, according to the present system of recruiting, many take refuge in the Army who are "wanted" by the police, and would strongly object to being finger-printed.

A few words should be added concerning the ancient usage of finger-prints in China, Japan, and India for legal purposes. Good evidence as to this has at length been supplied by Minakata Kumagusu in two letters to NATURE, vol. li., pp. 199 and 274. It is clear that it *was* used to some extent, but there is nothing as yet to show that the impressions were made and scrutinised with anything like the precautions now considered to be essential to the good working of the system. Blurred finger-prints cannot be correctly deciphered except by a trained expert, using lenses and photographic magnification. Negative evidence is often of conspicuous value, such as should leave no reasonable doubt in the mind of the most stupid juryman; but expert analysis and severe cross-examination are required when the prints to be compared are generically alike and when one of them is imperfect or blurred.

F. G.

EDUCATION AND PHYSIQUE.

Mécanisme et Éducation des Mouvements. By Prof. Georges Demeny. Pp. ii + 523; 565 figures. (Paris: Félix Alcan, 1904.) Price 9 francs.

THERE are few more important or more opportune considerations in connection with practical hygiene than those which are furnished by the subject-matter of the two books written by M. Demeny. The first of these books, a second edition of which appeared in 1903, is entitled "Les Bases scientifiques de l'Éducation physique"; this is now supplemented and given a direct practical bearing by the present work, which sets forth in some detail the technical aspects of the subject. As regards its general character the method of treatment remains distinctly scientific; but since the avowed aim of the author is to set forth the real advantages to be derived from bodily exercises conducted along proper lines, the scope of this later book is eminently educational, and thus it appeals to all those who take a broad view of education and its requirements. This appeal is accentuated by the mode of presentation, which is such as to render the extensive subject-matter intelligible to those who make no pretensions to special physiological knowledge.

It is true that the opening chapter deals of necessity with such physiological questions as the structure and functions of muscle, the mechanism of joints, and the capacity for movement which are allowed by the skeletal articulations; but these and other fundamental points of like nature are treated in a manner which, whilst in strict accord with the present state of scientific knowledge, is of such a character as to render these various topics easy of comprehension. This introduction leads up to a most interesting analysis of the part played by the muscles in producing various well known body movements. In this stress is laid upon the comparatively modern discovery that any movement, for instance the flexion of a limb, is produced not only by the pulling force of those muscles which move it in the desired sense, the flexors, but also by the relaxation of those which oppose this movement, the extensors. It is this two-fold muscular mechanism which permits of the movement being graduated so finely as regards both its extent and its force. Some illustrations of a striking character are given in support of this aspect of a volitional or secondary automatic movement.

For the majority of readers, the great interest of the book will probably lie in the interesting account which it gives of various familiar movements. These are all accompanied by numerous illustrations which are excellent for their purpose, and greatly enhance the attractiveness of the text. Many of these are spirited diagrammatic representations of the skeleton, the form of which in all manner of bodily postures is drawn with that piquancy and verve which constitute to English eyes the special charm of French draughtsmanship; humour cannot be expected in a letterpress which deals with subject-matter so technical and serious, but it is supplied by the illustrations, which give a humorous fillip to the work without detracting in the least from their undoubted service in helping the reader to follow the exposition.

The section which deals with the various forms of locomotion, walking, running, jumping, &c., is perhaps the most elaborate. The author is here on ground which he has studied minutely for many years. As chief of the laboratory at the physiological station in the Collège de France, he is able to set forth with authority the results of the elaborate and prolonged investigations initiated by Prof. Marey and carried on under his inspiring influence. It is probable that the summary of these investigations given by M. Demeny is the most valuable short exposition of this really difficult subject which has been published up to the present time. The lucidity of the author's style and treatment is conspicuous in this portion of the book, for the matter dealt with is not easily set forth in a way which admits of being readily understood, since it involves mathematical considerations which are apt to prove a stumbling block to physiological students.

But, as stated before, the description of the factors concerned in the production of familiar postures of the body and the side-issues which these raise, will for most readers probably prove the most attractive portion of the work. From standing, sitting, and lying down, the author proceeds to carrying loads, vaulting, kicking, throwing, swimming, rowing, cycling, horse-riding, dancing, singing, fencing, boxing, wrestling, and all the various bodily movements which are concerned in the various forms of athletic or industrial exercise. It would be impossible to give any detailed account of his treatment of these subjects, but it may be confidently stated that this treatment, whilst scientifically sound, is rendered

entertaining by the copious illustrations and interesting through the many novel points which are touched upon. As an example of the latter, the question is raised as to the physiological limits of the rapidity of effective response in fencing and boxing, and experiments are cited bearing on this point.

A more serious, and at the present moment more important, aspect of the subject-matter is that which deals with body movements in relation to the improvement of general bodily physique. These are dealt with in the same comprehensive manner as those just referred to, for the author includes most of the gymnastic exercises used in France, Swedish drill, the use of clubs and of apparatus of different kinds.

The malformation of the body is also referred to, whether due to the under-development or to the over-development of special muscular groups; as an example of the first, the malformation of the chest through the weakness of the trunk muscles, abdominal muscles, &c., is conspicuously shown; as an example of over-development, the malformation of the thigh in fencing masters.

The closing chapters are devoted to the conditions which may be presumed to determine how muscular force can be most economically directed towards the production of body movements. The author realises that it would be undesirable in a treatise of a semi-popular character to present this extremely important subject in detail; nor, indeed, can it be set forth in a very convincing manner, since several questions of a fundamental type are still from the scientific point of view in an unsettled state. Thus it is still a matter of doubt how closely the heat-producing properties of muscle are associated with those of mechanical tension or change of form. M. Demeny is well aware of this, and warns his readers that it is impossible to deduce the energy relationships of the animal mechanism from those of artificially constructed machines. In this as in other departments of physiology the hope of arriving at a more precise intellectual standpoint is that expressed by one of Bacon's aphorisms; it will "only be well founded when numerous experiments shall be received and collected into natural history which, though of no use in themselves, assist materially in the discovery of causes and axioms."

In this spirit the various experiments detailed in the concluding chapter of the book must be approached. Most of these are concerned with the influence of walking with definite loads for definite distances; the points noted were the number of steps per minute, the length of the stride, and the posture of the body. It appears that when, as in walking, muscular movements are repeated many times, then there is an optimum rhythm which, by permitting appropriate reparation, allows the maximum of effect with least expenditure of muscular power. The author considers this to be the case in almost all body movements, although experiments are not given in support of this generalisation.

The book as a whole is likely to prove of very considerable value in connection with the subject of physical degeneration, which has been for some time agitating the mind of the public. Methods of education it is now realised should, from the hygienic point of view, concern themselves with the posture of the body. In the code for 1905 issued by the Education Department stress is laid upon the importance of "the careful cultivation of a correct posture at writing and other lessons." This tardy awakening of the authorities to the importance of cultivating the bodily physique of the children who are taught in the national schools renders it probable that teachers will desire to instruct themselves in the fundamental scientific aspects of the various methods for improving the bodily structure and functions. In this respect a work such as that now under review is likely to prove of very real service; it is trustworthy, it approaches the whole question of body posture from a point of view at once scientific and utilitarian, it attacks the fundamental question (that, namely, of the effective action of the muscles), and finally, it is written in a style which makes the subject-matter intelligible without presupposing special technical knowledge on the part of the reader. The only drawback to its utility is one which is susceptible of removal by its translation into English.

F. G.

GEOMETRY OF POSITION.

On the Traversing of Geometrical Figures. By J. Cook Wilson. Pp. x+154. (Oxford: Clarendon Press, 1905.) Price 6*s.* net.

SUPPOSE that an outline figure of any kind is drawn upon a blackboard. In its construction the chalk describes a certain number of closed or open paths, a path being defined as the mark made by the chalk during the whole time of any one of its contacts with the board. But the number of paths thus actually described is not necessarily the smallest by which the figure can be produced, and it is an interesting problem to analyse a given figure into its minimum number of paths, each traversed once. As a simple example, let two oval paths be drawn intersecting in four points; the resulting figure can be traversed as one closed path. If two of the intersections are joined, the new figure can be traversed as one open path; if the remaining intersections are joined, the figure cannot be reduced to less than two paths.

The first two parts of Mr. Wilson's book deal with the problem above stated and various associated questions. The most interesting result is one of greater generality than might have been expected. Let a point in the figure be called odd or even according as an odd or even number of lines radiate from it; then a figure with $2n$ odd points can be analysed into n paths, but no fewer. (To include the case when $n=0$ a slightly modified statement is necessary, which will be found in the book.)

In part iii. the author enters upon new ground by applying the principle of duality; this is the most novel part of the book, and a few comments on it may not be superfluous. The results of the first two parts may, of course, be directly reciprocated without introducing any metrical considerations; but this is

not what Mr. Wilson does, and the consequences of his procedure are very instructive, especially from the point of view of absolute geometry. He practically confines himself to rectilineal figures, and reciprocates segments into angles, thus introducing metrical elements, and becoming necessarily faced by the complications which they involve. It is now familiar to pure mathematicians that, with an "absolute" conic to define our metrical system, there is a consistent and reciprocal definition of *angle* and *segment* (or *distance* of two points) by which each of these is the product of a constant and the logarithm of a cross-ratio. But to identify these with the expressions for angle and segment obtained by elementary methods with rectangular coordinates it is necessary to suppose the absolute conic to degenerate into one which, considered as a point-locus, is the line at infinity counted twice, and considered as an envelope is the pair of circular points at infinity. This complicated character of the absolute is at the base of all the puzzling difficulties which beset such attempts as this of Mr. Wilson's—difficulties, it is true, which he often surmounts in an ingenious manner.

For example, in the appendix he introduces a system of angular coordinates, both for lines and points, and obtains point and line equations for the ellipse. Now the unmistakable drift of his thought is that if point and line can be defined by coordinates which measure segments, then "reciprocally" line and point can be determined by coordinates which measure angles. But his angular coordinates are not really reciprocal to the segmental coordinates, as is clear from the fact that his equation of the ellipse is trigonometrical and not algebraical. It might be interesting to decide whether any simple functions of Mr. Wilson's angular coordinates are the direct reciprocals of the ordinary Cartesian segmental coordinates.

A remark should also be made on the note (pp. 120–6) on the most general form of the construction of reciprocal figures, as it may prevent possible misunderstanding. In the ordinary process of reciprocation with an auxiliary conic, F and F′ being the corresponding figures, we may say that F′ is derived from F by a process, or rule, of polarising, and that F is derived from F′ by the same rule. Mr. Wilson gives an example in which F′ is derived from F by one process, and F from F′ by another—F and F′ being reciprocal in the general sense of projective geometry. He adds that this is "wider than the usual method," which, of course, it is, if "the usual method" means employing an auxiliary conic. But the figures obtained by his method can be constructed each from the other by the general method of making four points (or lines) in F correspond at pleasure to four lines (or points) in F′, and then to every linear way of constructing F′ from F there is a dualistically corresponding way of deriving F from F′. So that it must not be supposed that Mr. Wilson has discovered any essentially new way of constructing reciprocal figures, though his remark might be misunderstood in that sense.

To return to the more popular aspect of this interesting book. The figures are, strictly, strips of black on a white ground. For the author they represent geometrical lines, and are reasoned upon as such. But the reader may give them different interpretations, and make up problems for himself accordingly. For example, let the lines in a diagram represent cuts made in a single piece of wood by a fret-saw; how many pieces are produced? What is the simplest wire model that will give a shadow like a given diagram? and so on. Stencilling, again, is full of problems analogous to those which Mr. Wilson discusses; knitting and netting give any number of examples of single-path figures. The proverb that "extremes meet" is curiously illustrated by these purely topographical questions, which suggest puzzles for children, problems for designers, and tools for logicians; while they appear with startling unexpectedness in the most abstruse mathematical theories—Abelian functions, group-theory, hydrodynamics, and electricity.

G. B. M.

ORGANIC PREPARATIONS AND THE COAL-TAR COLOUR INDUSTRY.

The Synthetic Dyestuffs and the Intermediate Products from which they are derived. By J. C. Cain and J. F. Thorpe. Pp. xiv+405. (London: Chas. Griffin and Co., Ltd., 1905.) Price 16*s*. net.

THE publication of this work is not without significance in its bearing on the oft-repeated statement that the great industry represented by the manufacture of coal-tar dyes is decaying almost to vanishing point in this country. The fact of publication presumes a demand which, in this case, must be mainly confined to those connected with, or training for, the manufacture referred to. It is unlikely that any great number of students in the colleges of this country are preparing for positions in colour works abroad, and it is therefore reasonable to assume that those concerned with the production of the book have satisfied themselves that the industry is not in such a parlous state as pessimists would have us believe. In any event, the book will powerfully influence one factor in the case—the proper instruction of students who are training for the industry.

Whether this touches the root of the matter is, however, doubtful. The gradual decline in importance of the manufacture of coal-tar products in this country has been variously ascribed to the deficient training given in the colleges, the bad patent laws, and the cost of alcohol, relatively to the conditions existing in Germany with regard to these matters. Concerning the work of the colleges, it is now generally conceded that the best of our schools of organic chemistry need fear no comparison with those abroad. The effect of our patent laws, both past and present, in handicapping the industry, has doubtless been very great; but possibly the inquiry of a Royal Commission, such as recently reported into the question of industrial alcohol, would show that, as has been conclusively proved with regard to the cost of alcohol, the effect of the patent laws on the non-

development of the English coal-tar colour industry has really been much less than has been supposed. A cause fundamental to those enumerated above, and lying at the basis of many other of our industrial lapses, may be defined as the lack of an appreciation of the importance of science on the part of the public generally. This has rendered the development of many industries quite impossible. It is reputably stated that the Badische Anilin- und Soda-Fabrik spent upwards of one million pounds sterling during a period extending over twenty years in solving the industrial problem of the synthesis of indigo. What English board of directors, even if themselves satisfied to do so, would venture to spend any such sum on apparently unproductive scientific experiments? Public opinion in this country, as reflected in the shareholders, would not allow it, any more than a six or seven years' college science course is considered a paying investment. Nor will satisfactory reform of the patent laws and the excise laws come about until the Government is made to realise, by the pressure of public opinion, that the future of the national industries largely depends upon the proper utilisation of scientific fact and method.

The work under review consists of three parts and an appendix. Part i. comprises a description of the various synthetic dyestuffs and the intermediate products from which they are derived. Part ii. gives methods for preparing typical products on a laboratory scale, but as far as practicable by works processes; and part iii. deals with the analysis and identification of dyes and with the detection of dyestuffs on the fibre. The appendix contains tables giving the specific gravities of various solutions.

The first chapter of the book gives a very short account of coal-tar and the separation and purification of benzene, naphthalene, anthracene, and phenol. A little more space might usefully have been devoted to this section.

Subsequent chapters deal with the nitration and sulphonation products of the hydrocarbons, and the production and properties of amido, hydroxyl, and carboxyl derivatives. The second section of part i. gives in seventeen chapters, occupying about one-third of the book, a systematic description of the various groups of dyes, the classification being, of course, based on the chemical constitution, and not upon the mode of application, of the dyes. The treatment of this section is excellent, the descriptions being very lucid and sufficiently exhaustive without too much detail.

Part ii., which deals with the preparation of colouring matters and intermediate products, is at once the most novel and the most useful feature of the book. It is evidently the outcome of much personal experience on the part of the authors, and the limitations of ordinary college laboratories have very sensibly been kept in view, though at the same time only such materials are employed as would be used in the technical preparation of the several products in the works.

Perhaps the least satisfactory portion of the book is the chapter dealing with the application of the colouring matters. It is very doubtful whether any useful purpose is served by such a short treatment of the science of dyeing as can be compressed into thirteen pages. Condensation to this extent inevitably results in misleading generalisation, and the authors would probably have been well advised to have referred their readers to some of the well known treatises on dyeing for this part of the subject.

The chapters on the valuation and analysis of dyes are to some extent open to the same criticism. As an example of their deficiencies, the method given for the analysis of indigo may be referred to. The method described would be entirely untrustworthy if applied to the estimation of natural indigos, and such is evidently the intention. In its main and essential sections, however, the book is a noteworthy addition to the literature of specialised organic chemistry, and both authors and publishers are to be congratulated on its production. WALTER M. GARDNER.

SCIENCE AND MYSTICISM.

Prinzipienfragen in der Naturwissenschaft. By Max Verworn. Pp. 28. (Jena: Gustav Fischer, 1905.) Price 80 pfg.

PROF. VERWORN detects mystical murmurs in the scientific camp, and is full of apprehension of coming dangers, for "mysticism is the negation of scientific thinking." Naturalists have been working out a monistic interpretation of the world, but there have been symptoms of faint-heartedness lately, especially before two questions, which the author states in the following terms:—Do vital processes depend on the same principles as the processes in inanimate nature? Are psychical processes referable to the same principles as those on which bodily processes depend? Verworn assures us that both these questions may be confidently answered in the affirmative, for the world is one, with the same principles, or rather with one principle throughout. What that "principle" is we have not been able to discover from the lecture, but we are assured that it is not a "mystical principle."

In regard to the first question, Prof. Verworn says that when we sufficiently analyse the criteria of life we find none requiring other principles than those which we require in interpreting the inorganic world. The only feature distinctive of life is the combination of potencies which are seen separately apart from life. Chemical ferments illustrate metabolism without growth; the condensations and polymerisations of chemical compounds illustrate growth without metabolism; the organism combines both. How it does so we are not told, but it is not by any peculiar vital principle. There is no need to assume a secret "organisation" transcending physical and chemical principles; there is no warrant for postulating a persistent protoplasmic architecture, either microscopic or molecular, as the physical basis of life; the form and structure of a cell is just like that of a fountain or a flame; life is a flux; "Πάντα ῥεῖ" is true throughout nature. To suppose, as Driesch, for instance, does, that an Aristotelian "entelechy" resides in

living matter and accounts for its purposive behaviour and development is to resurrect the buried concept of a *nisus formativus*. To do this is quite gratuitous, since Verworn supplies us with a guaranteed modern concept of a "self-steering" metabolism—the "self-steering" quality depending, of course, on the laws which physical chemistry has been revealing during recent years. He also assures us that there are no facts of organic being or becoming which warrant us in losing faith in the sufficiency of the monistic interpretation in terms of chemistry and physics. It is true that the illustrious physiologist has not found time in this lecture to give us any illustration of how any vital phenomenon may be formulated in terms of "the principles of the inorganic world," but he seems to have no doubt that it can be done.

As to the second question, before which so many have fallen away from monism—the question of psychical life as distinct from bodily life—Verworn finds satisfaction in boldly denying that any dualism exists. The dualistic idea was born out of ignorance fathered by desire, and it has been nurtured and refined by philosophy. The material ghost that escaped *in articulo mortis* has become a spiritual soul, but both are fallacious abstractions. It is pathetic to think of all the wrestlings with the problem of dualism since Descartes's day, for dualism is but one of man's many inventions with which he makes himself miserable. Just as the organism is a mere bundle of metabolisms, so the "ego" is but a changeful bundle of sensations, and perceptions, thoughts, and feelings derived from these—a complex the components of which are not continuously or simultaneously held in combination, though certain components, *e.g.* sensations of our body, occur so frequently and uniformly that the illusion of a persistent personality is produced. The material for the up-building of the "ego" is the external world or corporeal world—the world of sensations; the "make-up" of the "ego" is the same as the "make-up" of the world; the antithesis of soul and body is "a fossil idea." "Either everything is body in the world or everything is soul: however I like to put it, the main fact is that there is only one kind of thing." How a flux of sensations can give origin to that unified outlook and inlook which is called monism remains somewhat mysterious, but to think of any mystical principle being involved is "a negation of scientific thinking." But which is mysticism and which scientific thinking? J. A. T.

THE PLANT KINGDOM.

Das Pflanzenreich. Regni vegetabilis conspectus. Edited by Prof. A. Engler. (Leipzig: W. Engelmann; London: Williams and Norgate.)

AN account of the inception of this work was given in NATURE, October 30, 1902 (p. 657), with a list of the earliest parts. Twenty-one volumes have now been published, of which ten are devoted to monocotyledonous orders. The late Dr. K. Schumann has contributed, in addition to the Musaceæ, two memoirs on the Marantaceæ and the Zingiberaceæ respectively. In both these orders there is a large increase in numbers and a considerable amount of change as compared with the account given by Pedersen in the "Pflanzenfamilien." This is explained by the fact that an enormous number of new species have been made out of copious material received from Indo-Malaya and tropical Africa. The new species of Zingiberaceæ described for Malaya alone exceed a hundred. Dr. Schumann formulates very definite arguments in favour of the changes which he proposes in reviewing the history of the orders, and also presents a comprehensive discussion on the flower and on the relationships of the four orders which compose the series Scitamineæ.

Many of the orders are obviously too large to admit of their being treated in a single volume. The Orchidaceæ, as in the case of the "Pflanzenfamilien," have been entrusted to Prof. Pfitzer, and the first instalment contains the section Pleonandræ—formerly called Diandræ—which consists mainly of the Cypripediums as generally understood. A special feature of this volume is the list of hybrids, both natural and artificial. Similarly, the Araceæ require several parts, and Dr. Engler, who undertakes this order, begins with the tribe Pothoideæ. Dr. Engler gives a full description of the branching, and distinguishes nearly 500 species of Anthurium. A short volume includes the orders Scheuchzeriaceæ, Alismataceæ, and Butomaceæ, which are all worked out by Prof. Fr. Buchenau. Dr. W. Ruhland is responsible for the Eriocaulaceæ, and gives a detailed account of the geographical distribution, taking up the origin, evolution, and dispersal of the order. Owing to a large influx of new specimens from Brazil, the number of species of Eriocaulon now exceeds two hundred, and the genus Pæpalanthus, after being shorn of many species that form three new genera, still shows a slight increase.

The first volume dealing with a group of the gymnosperms, that on the Taxaceæ, has been written by Dr. R. Pilger. The Taxaceæ are profoundly interesting on account of the primitive forms which characterise some of the genera, but, as is usually the case with such genera, the number of species is small, and no great increase may be expected, although some new species may be looked for from the unexplored areas of China and eastern Asia.

Of dicotyledonous orders, the Tropæolaceæ, by Prof. Fr. Buchenau, appeared in 1902, and the Cistaceæ, by Dr. W. Grosser, and the Theophrastaceæ, by Prof. C. Mez, were issued in 1903. Since that time a larger volume on the Lythraceæ has been contributed by Dr. E. Koehne, who has gone very fully—in fact, more fully than seems necessary—into the varieties and forms of the more variable species. The genus Cuphea is amplified to 200 species, and the genus Rotala is extended to include some species previously assigned to Ammannia. A list of plant collectors and their contributions is added. One of the most complete and interesting memoirs is that by Prof. H. Winkler on the Betulaceæ. The general sketch contains sections on the geographical distribution and the history of the order. The fossil forms, which are numerous, are enumerated without comment, but with references,

and—a feature that one would have expected in every volume—maps are provided to indicate generic distribution.

The main purpose of the "Pflanzenreich," as contrasted with the "Pflanzenfamilien," is to provide an authentic description of species, and criticism of this work has largely to deal with considerations that are best known to the learned authors who have undertaken to write on the different orders. One of the main difficulties consists in reconciling the diverse views held by different writers who have made a special study of the same orders and groups. The discussion of certain forms under *Betula papyrifera* furnishes an instance in which Dr. Winkler holds different views from Prof. C. S. Sargent; without attempting to judge between the two opinions, it would seem that Prof. Sargent has had better opportunities of studying these forms, but it should be added that in this case the writer has fully stated both views: the ideal solution in such a case would be a collaboration of both authorities, if such a collaboration were practicable. It is from this point of view that one could have wished to see the names of other besides German botanists associated with this great undertaking; so far, Dr. Rendle, who wrote the volume on the Naiadaceæ, is the only exception. The commendable spirit of *camaraderie* which exists between botanists has been amply demonstrated in the various international meetings, of which the latest was recently held in Vienna, and it would not appear to be a matter beyond practical realisation to give a more international character to this *magnum opus*.

AN ITALIAN TEXT-BOOK OF PHYSIOLOGY.

Physiologie des Menschen. By Dr. Luigi Luciani. Ins Deutsche übertragen und bearbeitet von Dr. S. Baglioni und Dr. H. Winterstein. Dritte Lief., pp. 323+502+viii. Vierte Lief., pp. 160. (Jena: G. Fischer, 1905.)

THE general features and aims of Dr. Luciani's text-book of human physiology have already been alluded to in the review of the first two parts, and need not be recapitulated here. The first few pages of the third part complete the account of the physicochemical phenomena of respiration. The following chapter gives an excellent account of the mechanics of respiration, including the influence of the respiratory movements on arterial and venous blood pressures.

The succeeding chapter, on the nervous mechanism of respiration, is specially good, and one cannot fail to admire the mastery of the literature of the subject shown by the author, every page giving evidence of knowledge of the original sources. The subject of the localisation of the bulbar, spinal, and cerebral respiratory centres is fully dealt with, the results obtained by the earlier observers—Legallois, Flourens, Schiff and others—being well epitomised. A good *résumé* is also given of the important later results obtained by Gad and Marinescu on the localisation of the bulbar respiratory centres. Reference is also made to the interesting results yielded by Aducco's research on the action of cocaine upon the respiratory centres.

The author next gives an account of the influence upon the respiratory centres exerted by stimuli transmitted by afferent nerves. A considerable amount of space is devoted to the important work of Hering, Breuer, and others on the self-regulatory mechanism subserved by the vagi. The later experiments of Head have been omitted.

The subjects of apnœa and periodic respiration are discussed with great fulness, much of the author's own work being given.

The next chapter deals with lymph—its sources, physical, chemical, and morphological characters, its circulation, and the theories of its formation. An excellent critical account is given of the secretion theory of Heidenhain, as compared with physicochemical theories of the majority of later workers in this field. In the concluding pages of this chapter the structure and functions of the lymph glands and lymphoid organs—bone marrow, thymus, and spleen—are fully described.

The first chapter of the second volume is devoted to the subject of the internal secretions of the ductless glands. After a brief introductory account of the historical development of our knowledge of glandular secretion, the author passes to a detailed description of the structure and functions of the thyroid and parathyroids. The treatment of the physiology of the thyroid and parathyroids is so complete and full of interest that only a brief reference to the most salient points is possible. The various theories which have been held with regard to the results of removal are critically reviewed. Very full treatment is accorded to the experimental foundations for the theory of an auto-intoxication. In this connection, the results obtained by Colzi and others by means of the method of crossed transfusion are of great interest and importance. Gley's ingenious experiments on the relative toxicity of the blood serum of normal dogs as compared with that of dogs from which the thyroids had been previously removed are also fully described. An important section of this chapter is devoted to the theories of independent specific functions of the thyroid and parathyroids, and to the experimental basis on which these theories are founded.

The structure and still obscure physiology of the pituitary gland are briefly epitomised. A satisfactory account is next given of the structure and functions of the suprarenal glands, although in this case the results obtained by English workers have not been sufficiently recognised by the author.

The following chapter deals with the external digestive secretions of the salivary glands, pancreas, gastric and intestinal mucosæ, and liver. The final chapter is devoted to the mechanical and chemical phenomena of buccal and gastric digestion. The account has been kept well abreast of the most recent advances, many important additions being made by the translators.

A perusal of the third and fourth parts strengthens the impression that the complete work will prove itself to be a most trustworthy and illuminative guide to modern physiology.

J. A. Milroy.

ANOTHER "NIVOC" PAGE.

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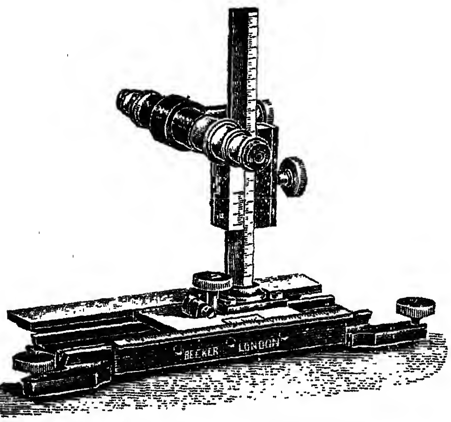

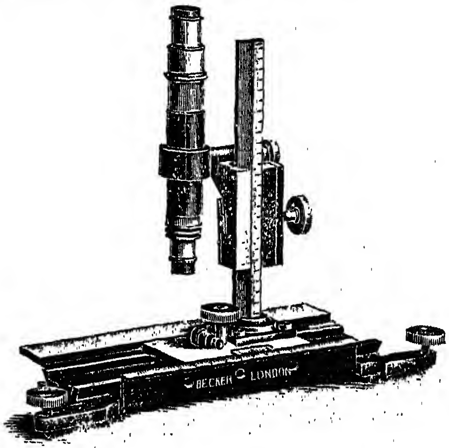

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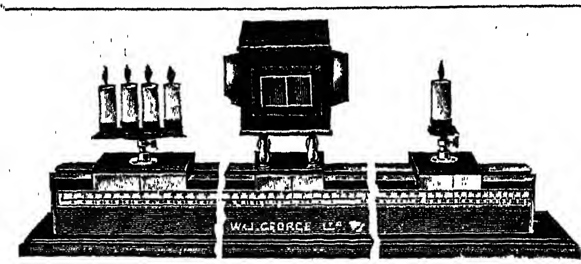

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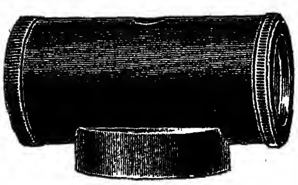

Fig. 1.

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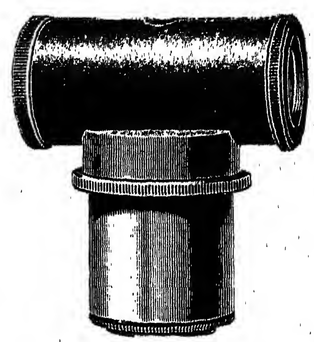

Fig. 2.

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in working, this high pressure must be transformed down into a low one at the distant end of the transmission system.

But what did high pressure—produced with a dynamo—mean twenty-six years ago? Why, three or four hundred volts—what, in fact, is called low pressure to-day—a pressure less than is now often used for lifts in buildings, pumps in mines, and tramcars in streets. And how was it proposed to transform this so-called high pressure into a low one? Why, I suggested mechanically coupling a 400-volt direct-current motor to a 50-volt direct-current dynamo—the device that has since been called a "motor generator"—and such a combination was shown in operation at that lecture.

But it was in Paris, at the Palais de l'Industrie, the home of that electrical exhibition of 1881 which has now become classical, that modern electrical engineering was born, and shortly afterwards *Punch* exhibited the young infant thriving, and imbibing liquid nourishment from a storage cell.

"What *will* he grow to?" says the picture. What *has* he grown to? Aladdin's ring, Aladdin's lamp—whose slaves brought a fortune to him, and a fainting fit to his mother—were but poor magic makers compared with the ring evolved by Gramme and that boy, Paccinotti—compared with the lamp constructed by those veterans Edison and Swan.

In the "Arabian Nights" it is stated that Aladdin's would-be uncle, the noted and learned African magician, knew that the wonderful lamp was not fed with oil, and he anticipated by many centuries the plan for reconciling the inhabitants of Johannesburg to having the electric pressure in their houses raised from 110 to 230 volts—for did not he, like the municipal African magician, offer "new lamps for old?"

It is also described how the lamp enabled Aladdin to carry off the Princess Badroulboudour, and the wicked uncle to transport the palace. But electric traction has carried off whole neighbourhoods out of cities into suburbs, and, by transporting hundreds of thousands daily, has helped to solve the problem of housing the working class; while electric distribution of power has discovered, not caves of buried jewels, but waterfalls of ever-flowing wealth.

At the mines near Silver City, Idaho, for example, coal had reached seventy shillings a ton, wood thirty-six shillings a cord. For years the distribution of power was by donkeys, or by long teams of horses slowly hauling heavy loads of wood up the mountain road; and then the magician of this, the electric age, came to Idaho, and what those mines need—power, clean, dustless, weightless power, now courses up the mountain side from Swan Falls on Snake River in the valley below. What fairy of old, who could change dead leaves into jewels, ever worked such beneficent wonder? See how proudly those posts look down upon their conquest of the past. For have they not brought an end, not merely to wasteful extravagance in lifting fuel up to those mines, but also to needless toil for tired cattle?

In 1886, when the boy Electricity was five, the babe Johannesburg was born, and the two youngsters have raced along neck and neck. To-night I will tell you something of their lives.

Nine years after that first lecture, the British Association honoured me by asking for another. In 1888, however, it was beginning to be realised that a pressure of 2000 volts between electric mains might not make too great a call on the funds of life insurance companies. Alternate current transformers had come into use; Ferranti was employing them practically, for distributing electric current from the Grosvenor Gallery, Bond Street. A "transformation scene" Lord Kelvin called the apparatus at that lecture. The male white population of Johannesburg was now—2000.

But, although current, at 100 volts pressure, was beginning to be distributed for electric lighting, the distribution of power for working electro-motors was still but a dream of the future.

In exactly a decade after the Paris Electrical Exhibition of 1881 came the Frankfort Exhibition of 1891. More than ten times 2000 volts was there used to transmit more than 100 horse-power, more than 100 miles, with more than 75 per cent. efficiency.

A death's-head and cross-bones were painted on every post along that 100 miles of railway line, Lauffen to Frankfort, for he who should touch those bare wires, with a pressure of 25,000 volts between them, secured electrocution; and a similar suggestion of mortality greets the wayfarer—in his own language, be he English or Dutch—on the posts of the Rand Central Electric Works.

	1882 Hirschau to Munich	1883 Vizille to Grenoble	1886 Creil to Paris	1891 Lauffen to Frankfort
Pressure at transmitting end in volts	700	3000	6000	25,000
Horse-power delivered by electro-motor ...	5·8	7	52	114·2 to lamps
Distance in miles ...	3·5	8·75	35	108·7
Percentage commercial efficiency of transmission	36	62	45	75·3
Diameter of line wire in inches	0·18	0·079	0·2	3 wires each of 0·158
Material of wire... ...	—	Silicium bronze	Copper	Copper

The table shows that the use of higher and higher pressures has enabled larger and larger amounts of power to be transmitted longer and longer distances, with greater and greater efficiency, that is, with less and less waste. Now, why is this?

The electric current, as you know, is used for lighting buildings, driving machinery, propelling cars and trains. But throw away the notion, if any of you still have it, that electricity is a kind of gas, or oil, or fuel that is used up in these operations. The common expressions, buying electricity, consuming electric current, are most misleading, for just as much electricity flows away per minute—through the return conductor—from your electrically lighted house as flows to it through the coming conductor. If, therefore, it were electricity that you had undertaken to pay for, you must have made a very bad bargain, because you do not retain the smallest portion of what you would have agreed to purchase.

The electric current is like a butcher's cart carrying round meat—you no more consume current than you consume cart. It is not the vehicle, but what it leaves behind that the consumers buy—meat in the case of the butcher's cart, and energy in the case of the electric current.

Exactly the same considerations apply to the distribution of power, with air at 70 lb. pressure per square inch, to the thousands of rock drills on the Rand, to the distribution of power with water at 425 lb. pressure per square inch down the shaft of the Rietfontein Mine, and at 750 lb. pressure in the workshops of the Central South African Railways at Pretoria.

The energy conveyed with air, with electricity, or with water is made up of three factors—(1) the current, (2) the time during which it flows, and (3) the pressure under which it flows; while power depends on the current and the pressure only.

Few words are used more vaguely than this one "power." Before starting for South Africa some of us gave someone a power of attorney; we came on a ship of 12,000 horse-power; the voyage did us a power of good; at the concert on board we sang of the power of love.

In engineering, however, power has one very definite meaning—the rate of doing work—and a stream of air, of electricity, or of water exerts much power, that is, works rapidly, when it quickly loses pressure, or head. Quickly losing one's head, however, is not characteristic of large brain-power, and the power exercised by those who sit in high places is often much in excess of their rate of doing any kind of work.

When water has but a few feet of head, the quantity flowing over a water-wheel must be large if much work has to be done. But since the water usually comes to a

low pressure wheel along an open stream, and flows away again also along an open stream, no expense has to be incurred in laying down large pipes. If, however, it were necessary to distribute much power over considerable distances through a pipe conveying such low-pressure water, the pipe would not only have to be long, but of large cross-section, and, therefore, very bulky and costly. For example, this model is a full-size representation of the transmission of only one horse-power with low pressure.

On the other hand, if the water possesses considerable head, the transmission pipe may be of small diameter. In this second model the three-cylinder pump produces a pressure of 425 lb. per square inch, exactly the pressure used in the hydraulic transmission of power down the shaft of the Rietfontein Mine, and with that pressure less than four gallons of water flowing per minute through this three-quarter inch pipe gives as much power to this turbine as would be delivered by 825 gallons pouring per minute over this water-wheel four feet in diameter.

The water pressures in these two illustrations bear about the same proportion to one another as the electric pressure in the Lauffen-to-Frankfort transmission bears to the electric pressure usually maintained between the terminals of a lamp in Johannesburg.

The value of using pressure water is grasped when you realise that at the Rietfontein Mine, by circulating about 85 gallons of water per minute, at 425 lb. pressure per square inch, through a pipe 16 square inches in cross-section, not only is the circulating water all returned to the top of the mine, but in addition 144 gallons are pumped up per minute from a depth of 546 feet through a pipe $38\frac{1}{2}$ square inches in cross-section.

The water supplied by the London Hydraulic Power Company at 1700 feet head, although not filtered, costs nearly four times as much per gallon as the filtered water furnished by the Metropolitan Water Board. In England dirty pressure water is a relatively costly commodity, sparkling drinking water a relatively cheap liquid. In Johannesburg, on the other hand, until quite recently, the charge for drinking water was ten shillings a thousand gallons, plus two-and-six a month for meter rent, or about twenty times the London rate—the temptation to drink other things in Johannesburg must have been very great. Now, since the establishment of the Rand Water Board, it is six shillings a thousand gallons, which, without meter rent, is still ten times the London price, so that liquid with a head in London is still cheaper than plain drinking water here.

In the distribution of power, current and pressure are equally important. It is not merely because, even this month, August, after a phenomenally dry season, about 5,000,000 gallons of water are rushing per minute over the Victoria Falls, but it is because this water also thunders down about 380 feet that these falls are a potential source of power.

The Howick Falls, near Pietermaritzburg, have nearly as much head as the Victoria Falls, and twice as much as Niagara, while a syphon of soda water, when the gas is first pumped in, holds its head higher than any of the three. But, although in Johannesburg you probably pay a shilling for a syphon of soda water as an energy-producer in man, it is not worth 1/10,000th part of a penny as an energy-producer in a turbine, there is so little of it—only a pint and a half.

Probably, like myself, you have heard vague comparisons made between the power of the Victoria and the Niagara Falls. Now, what is the true comparison?

The flow at Niagara varies at different times of the year from about 62 to 104 million gallons per minute. At the Victoria Falls the flow can be as little as one-twelfth of the smaller number—for it is so now; and some authorities, well acquainted with the spot, say that at the end of another three months the flow will only be half of even that. The mean available drop at Niagara is about 160 feet; at the Victoria Falls about 380 feet. Hence, while the *minimum* Niagara flow represents about 3 million horse-power, the *present* Victoria flow represents about 580,000 horse-power, or only about one-fifth of the Niagara flow. Further, if those who predict the flow of the Zambesi sinking to something like $2\frac{1}{2}$ million gallons per minute in November are true prophets, the Victoria Falls will then only give out about 300,000 horse-power, or, say, one-tenth of the *minimum* that Niagara produces.

In all that precedes, I have taken the full power of the direct drop in each case; that is, I have assumed in each case the intake to be close to the main drop, and I have deducted nothing for inefficiency of machinery.

Now, how exactly does the efficiency in the electric transmission of power depend on (1) the pressure, (2) the power transmitted, (3) the length of the transmission line, and (4) the resistance of the conductors composing it?

The very simple approximate formula connects these quantities:—

$$\left.\begin{array}{c}\text{Percentage}\\ \text{loss of}\\ \text{power on}\\ \text{the road.}\end{array}\right\} = \frac{\text{Horse-power transmitted}}{3\ (\text{thousands of volts})^2} \times \text{miles} \times \left\{\begin{array}{c}\text{Resistance}\\ \text{per mile of all}\\ \text{the conductors}\\ \text{in parallel.}\end{array}\right.$$

This formula tells us that as long as the electric pressure is limited to some 10,000 or 11,000 volts—a pressure boldly used as early as 1897 by the Rand Central Electric Works, and at the Moodie Mines, near Barberton, but the one that is still the maximum sanctioned in Great Britain—it will not be possible, even with a pair of conductors of good copper, each as thick as the one I hold in my hand, viz. three-quarters of an inch in diameter, to transmit more than about 6000 horse-power, or to transmit that power more than about 10 miles, without the loss on the road exceeding 10 per cent.

The actual efficiency will, of course, be less than 90 per cent., since there will be losses also in the machinery at each end of the transmission system.

If, however, the electric pressure be doubled, that is, raised to 20,000 volts, then through this pair of conductors (kindly put up by the Transvaal Technical Institute, to bring power from their dynamo room to this hall), which are not much more than one-fifth of the cross-section of the former, and therefore not much more than one-fifth of the cost, as regards copper, we can transmit 2700 horse-power 23 miles, and still only lose 10 per cent. on the road.

Now Brakpan, where is the generating station of the Rand Central Electric Works, is almost exactly 23 miles from Johannesburg. Six wires come thence to Johannesburg, three of which may be likened to the going conductor, and three to the return in a two-wire system like this, also any three of those wires have a joint cross-section rather larger than three times the cross-section of this. Hence, with 20,000 volts, about 8000 horse-power could be sent to Johannesburg from Brakpan through the existing wires with only 10 per cent. loss on the road, or about 3400 horse-power (which is rather more than the entire maximum output of that generating station on any occasion last year) could be sent with only 4 per cent. loss.

I should have liked to show you this experimentally, but Mr. Reunert, Principal Hele Shaw, and Prof. Dobson, who, since my arrival, have so kindly put themselves to so much trouble to give expression to my wishes, might have thought me a little exacting had I asked for a lecture hall big enough to include a transmission line from Brakpan; and so, instead of this pair of conductors connecting two places 23 miles apart, I am going to employ a pair of extremely fine wires, each less than 1/100th of the diameter, that is, less than 1/10,000th of the cross-section—so fine, in fact, that you cannot see them.

Switch on the current, more than 100 lamps glow. Now think of a wall of lamps ten times as high, then ten times as wide, and then six times as big as all that, and you will have 2700 horse-power; and that is the power which, put into this pair of wires 23 miles away, say at Brakpan, with this pressure of 20,000 volts, will cause about 2400 horse-power to come out at Johannesburg.

This experiment of transmitting *five* horse-power across the hall is the nearest approach to wireless transmission of power that I have ever seen. But there are wires, although invisible, for if I make them touch at one point with this long stick a flash occurs above your heads, and the glow lamps on the platform go out.

I directed your attention to the fact that in 1888 the male population of Johannesburg was 2000. By 1896, according to the census taken that year, it had grown to 32,387. Now, curiously enough, in 1897 two transmissions

were arranged for at 33,000 volts—the one at Crofton, California, and the other at Redlands, California; and no pressure higher than that used on the Lauffen-Frankfort transmission seems to have preceded this 33,000 volts anywhere in the world. Indeed, it would almost appear as if electrical engineers were waiting to use a higher pressure than 25,000 volts until the publication of the census of Johannesburg.

In 1898 the highest working pressure in the world was 40,000 volts for a 34-mile transmission at Provo, in Utah, and the male white population in Johannesburg was also about 40,000. Then came the war, and volts beat white man, for, according to the census of last year, while the white male population was 52,106, there were several examples of transmissions at 60,000 volts, as seen from the following table.

Year	From	To	Country	Transmission distance in miles	Horse-power transmitted	Pressure at transmission end in volts
1897	Crofton	—	California	—	—	33,000
,,	Redlands	—	,,	—	—	,,
	—	Bangalore	India	92	4,300	35,000
1898	Provo	—	Utah	32	—	40,000
—	Gromo	Nembro	Lombardy	22	3,300	,,
—	Logan	SaltLakeCity	Utah	150	2,600	,,
—	Canyon Ferry	Butte	Missouri	70	5,700	50,000
—	Shawingan	Montreal	Canada	90	15,000	,,
—	Moutiers	Lyons	France	112	—	57,600
—	Spokane	Washington	—	100	3,000	60,000
—	—	Guanaguato	Mexico	104	4,000	,,
—	Electra	San Francisco	California	147	10,000	,,
—	Colegate	Stockton	,,	218	5,000	,,

But with the influx of the white members of the British Association doubtless the tide will turn, white man will make a spurt and catch up electric pressure, and in this respect, at any rate, the Witwatersrand will become a white man's country.

Indeed, not only have various successful 60,000-volt transmission schemes been carried out, but the Kern River Power Company in California is constructing one for transmitting 4020 horse-power over 110 miles at 67,500 volts.

Transmission at 67,500 volts over 110 miles. Why, when the new railway—Brakpan to Witbank—is completed, 110 miles will be 20 more than will separate the Rand from the coalfields at Witbank—fields that produce such good coal that the Central South African Railways have contracted to purchase 84,000 tons during this year, at six shillings per ton at the pit's mouth. Now, at a pressure of 67,500 volts, these two small wires could, without becoming too warm, bring about 9000 horse-power from Witbank and deliver 7600 of it to the Rand.

Or if six wires were used like those now employed by the Rand Central Electric Works, then, at 67,500 volts, 9000 horse-power might be put in at Witbank and only 5 per cent. lost on the road, that is, about 8550 horse-power delivered on the Rand.

But the insulators would have to be placed much farther apart than on the existing Rand posts to prevent the starting of a brush discharge between the wires—a subject to which I will return.

You will now grasp why in 1895, ten years ago, it was a bold and pioneering policy to equip the Rand Central Works for 10,000 volts, and to use 13,000 volts during times of full load, and why in 1905 the recommendation of some advisers to distribute power at only 10,000 volts to the proposed substations of the contemplated 57 miles of electrified railways—Springs to Randfontein—is most retrograde of those advisers to the railway.

In 1879, a firm of electrical contractors, well known then, and equally well known now, told me that they had been asked to tender for the construction of an electric transmission system to convey a comparatively small amount of power 10 miles. But since they considered that they could not possibly hope to deliver more than half, while, in practice, they feared that they would only succeed in delivering much less, the proposal had to be ranked with the exploits of Gulliver and Baron Munchausen, and so even that firm declined to tender. To-day, twenty-six years later, electric power is, from an engineering and from a business point of view, being successfully transmitted 232 miles—nearly as far as some of you took fifteen hours the night before last in being transmitted from Ladysmith.

Now, how are these electric pressures of 10, 20, 30, 40, 50, 60,000 volts produced? Why, by means of the alternate current transformer, which does for electric power exactly what the lever does for mechanical power. Exert a small force through a long distance at the long end of this lever, and you have a large force exerted through a short distance at the short end. Apply a small electric pressure with a large current at one side of this transformer, and you have a large pressure with a small current at the other. But there are no moving parts, therefore the arrangement is called a "static transformer." It requires no adjustment from day to day, therefore it may be kept entirely immersed in oil to improve its insulation.

Such statical transformers I used to step up the pressure from 100 to 20,000 volts at the transmitting end, and to step down the pressure from 20,000 to 100 volts at the lamp end in the last experiment. Everything looked quite harmless until I intentionally brought the transmission wires into contact. So does the transformer, immersed in a huge cylinder of oil, now projected on the screen, although it regularly produces 60,000 volts, and can supply 1100 horse-power at that pressure. So does this water-cooled transformer (the interior of which is seen in an X-ray picture to the right, and the exterior to the left), although it can supply 2000 kilowatts, that is, 2700 horse-power. Its size can be realised by comparing it with the tiny transformer by its side—the size of the one which I have on this table.

60,000 volts, well, what of it? some of you may say. It cannot start a discharge between even sharp needle points separated by a greater distance than about six inches, and some of you have produced such a spark with an electrical machine—I am producing such a one now.

But each time that a spark passes between the terminals of the electrical machine the pressure is relieved, so no arc is maintained. Bring the terminals of that transformer within six inches of one another, however, and a roaring arc of 2700 horse-power will be kept up, dealing destruction around.

Let me show you a spark started with a 70,000-volt transformer when supplied with only one horse-power. What a banging is produced. Now picture to yourselves what would be the result if the power were not of one, but of 2700 horses, such as that transformer can furnish.

The photographs show the sort of discharge that may occur over the surface of an insulator 1 foot high—such as is used on a high voltage transmission line—when the testing voltage is 80,000 in this case and 105,000 in that, and when there is plenty of power to maintain the arc. It is veritable lightning, not a mere flash, but a continued flame; and the sort of insulator that is used in practice for a 70,000-volt transmission is realised by looking at the specimens, which are only intended for 10,000 volts.

There is nothing new in high voltage by itself—it existed in the period of the frictional electrical machine more than 100 years ago, but it was associated with only a very small current; next, dating from the development of the dynamo, came the low voltage large current period; and now we have entered on a third era, the high pressure moderate current period, that is, the period of high pressure combined with horse-power.

Next I come to a very important question, and one that merits far more consideration than it has yet received. There are two kinds of electric current—direct current and alternating current. Direct current is like a continuously flowing stream of water, such as, for example, the one that flowed through this pipe and drove this turbine. Alternating current, on the contrary, is like this band, which, although swinging backwards and forwards, also turns a wheel in one direction at the other end. Now, which kind of electric current should be used for the dis-

tribution of power over *long distances*? Practically, every electrical engineer will at once reply, alternating, of course. Well, I am going to preach heresy. I say direct current!

The alternating current has undoubtedly the great advantage that a motor can be constructed with no rubbing electric contacts, every wire may be permanently soldered in position, a condition of considerable importance in dusty places like mines. Here is such a motor—the first polyphase motor ever sent from America to Europe, the first ever seen in Great Britain, constructed seventeen years ago by Tesla with his own hands, when he was too poor to employ a workman.

Another advantage possessed by an alternating current is that an alternating current dynamo can be constructed to produce a large horse-power at a high voltage, and further, as we have already seen, this alternating voltage can be transformed into a still higher one without the use of moving machinery.

This is one of the five largest dynamos in the world. Its size you can better estimate by looking at the ring standing on end, now projected to the left. The latter is the stationary portion of a 5000 horse-power horizontal shaft dynamo, while the photograph to the right is that of a vertical shaft machine of double that power, viz. a dynamo that can develop 10,000 horse-power at a pressure of 11,000 volts. Fifteen years ago, Ferranti—the Brunel of electricity—spent a mint of money constructing some of the parts of a 10,000 horse-power, 10,000 volt alternator, which were, however, never put together. This dynamo projected on the screen stands complete, with its four sisters, in the Canadian Niagara Power House, and the tests already made show that its efficiency reaches the extremely high value of 98·2 per cent., that is, 1·8 per cent. of the power developed is sufficient to cover all losses. Ferranti's dream is more than realised, and the old story is repeated. We break up the pioneer leviathan, the *Great Eastern* steamship, as a great unwieldy giant very weak in its knees, a little later we build the *Baltic*, a third as large again, and with twice the engine power.

Without any transformation at all, these dynamos will economically drive machines some miles away, and, with the pressure transformed up from 11,000 to 60,000 volts, power will be distributed in Toronto, 85 miles away from the falls.

Contrasted with this, no single large *direct* current machine has ever been constructed to generate more than about 3500 volts, and no means is known for efficiently converting a direct current voltage into a higher, or a lower one, without the use of moving machinery.

So far, then, my case seems weak! The advantages of using great electric pressures we have seen. Are there any disadvantages? This is a disadvantage, the risk of piercing the insulation! See how thick the insulating material has to be on cables, how far apart the conductors have to be placed, even when the cable is intended for only 10,000 volts. But does this consideration supply any argument for or against the use of one kind of current rather than the other? Small current and high pressure must be used for the economical transmission of power over long distances, whether the current be alternating or direct, I agree; but, ladies and gentlemen of the jury, I submit that, while from the point of view of economic transmission, 60,000 volts alternating means exactly the same as 60,000 volts direct, from the point of breakdown of the insulation, 60,000 volts alternating is as bad as 85,000 volts direct, indeed may be worse than 100,000 volts direct. For an alternating current consists of waves like the waves of the sea. In a storm, the waves may be running mountains high, and yet the average depth of the sea remains the same as in a calm. But what does it benefit the poor passengers, when tossed helplessly backwards and forwards in their berths, and feebly calling "steward," to be assured that, although the waves be peaked, and the maximum elevation large, the square root of the mean square of the amplitude of oscillation is quite consistent with perfect internal tranquility? And so feels the poor insulating material—the mean electric pressure may not be very large, and yet the crests of the waves may be so high, and the troughs so low, that its strength cannot stand the electric tossing.

Each of those waves of electric pressure on the diagram gives the same reading on a voltmeter, but the peaked one has far more destructive action than the flat topped one.

But there are other disadvantages in the use of alternating current. This coil of wire represents one of the conductors which, when unwound, might join two places, the one where incandescent lamps (for example) have to be made to glow, and the other where is the water-power which drives the dynamo that generates the current. If a *direct* pressure of 100 volts be applied at one end of the system, the lamps at the other end glow brightly, as you see, whereas if now I apply an *alternating* pressure, although of exactly the same value, the lamps are quite dull.

The explanation of this striking difference is that in such a case only a fraction of the *alternating* pressure is used in making the lamps glow, the remainder being employed in maintaining a rapidly reversing magnetic field.

This magnetic effect—this self-inductive effect as it is called—is small if the going and return conductors be straight, short, and near together. But if the distance over which the power is to be transmitted be long, the wires obviously cannot be short, and if to obtain economy high electric pressure be used, the wires cannot be put very near together, since that would lead to a brush discharge through the air from one conductor to the other, producing leakage.

Indeed, the minimum distance that must separate the conductors has to be increased very rapidly with the pressure unless their diameter is greatly increased at the same time. The table gives this minimum distance for conductors 1/10th, 2/10ths, and 4/10ths of an inch diameter respectively, and it will be seen that increasing the thickness of the wire greatly diminishes this minimum. For instance, at 80,000 volts, doubling the thickness of the wire from 1/5th to 2/5ths of an inch diminishes the minimum distance from 6½ feet to 13½ inches.

JOHANNESBURG.

Elevation, 5689 feet, January, 1905. Barometer, 24·3 inches. Temperature, 91°·5 F.

Minimum distance that must separate two parallel wires to prevent the starting of a Brush Discharge.

Root mean square electric pressure in volts between wires	Diameter of wires in inches		
	1/10	2/10	4/10
40,000	8·8 in.	—	—
50,000	32·2 in.	—	—
60,000	9·9 ft.	14·7 in.	—
70.000	35·7 ft.	33·8 in.	—
80,000	—	6·5 ft.	13·6 in.
90,000	—	—	23 in.
100,000	—	—	38 in.

It must, of course, be remembered that these are minimum distances, and that the distances apart at which the wires have actually to be fixed in practice are much greater.

But that is not the whole indictment against the use of alternating current for *long distance* transmission. Leakage from wire to wire can be rendered small, but still, if the current be alternating, it always flows along the wires, even if all the apparatus at the distant end be entirely disconnected from them. Let me show you this.

I apply a direct pressure of 100 volts, and no current enters the transmission line, for it is well insulated along its length and at its ends. I apply instead an alternating pressure of the same value, without making any other change, and you observe a very perceptible current. The very first thing that struck Ferranti when he commenced transmitting power with alternating current at 10,000 volts pressure, from Deptford to London, was that the current flowing into the system at Deptford was as large during the daytime, when practically no lamps were turned on in London, as during the evening, when many were glow-

ing. Again, in the case of the 150 miles transmission, at 50,000 volts, by the Bay Counties Power Company, in California, it was found that to charge even the aërial lines as a condenser required 40 amperes, so that the current flowing into the system remained practically unchanged when the useful load was decreased from several thousand horse-power down to nought.

Now this is the very opposite of the effect we previously noticed, for in that case it was the alternating pressure that left the lamps dull by failing to send enough current into the transmission system. Surely, then, the one effect is a correction of the other. That is so, and I will give you a practical illustration.

I have here two transmission lines, the one with its going and return conductors placed far apart so as to exaggerate the first effect, the other with its going and return conductors near together to exaggerate the second effect; indeed, as I am employing for this experiment only a pressure of 100 volts, there is no risk of brush discharge, and so I have put the wires extremely near together on the second transmission line. The alternating current produced by the dynamo divides itself between the two transmission lines, and the two branch currents are about equal.

But, as you may see by means of the oscillograph—an instrument developed in my laboratories by Mr. Duddell, one of my students, for giving us a picture of the current and pressure waves in each of the two circuits—there is a great difference between the waves in the two circuits. In the transmission line with the wires far apart, the reversals of the alternating current occur after the reversals of applied pressure, the crests of the current wave lag behind the crests of the pressure wave, whereas in the case of the transmission line, with the wires very near together, the exact opposite occurs, viz. the crests of the current wave are in advance of the crests of the pressure wave.

Now, in the circuit coming from the dynamo, both current waves exist together, and as the crests of the one wave coexist with the troughs of the other there is interference, and the result is practically no current at all. So here we have the rather surprising result of practically no current in a main circuit, and yet a considerable current in each of the branch circuits into which the main circuit divides.

This may perhaps be regarded as a beneficial result, and should be added to the score of alternating current. But just as a very small alternating current in the main circuit can be split up into two large currents in the branch circuits, a small alternating pressure can be split up into two large alternating pressures, and in that case the result must be scored against the use of alternating current.

In this experiment I use also two circuits, one with the conductors very far apart, and the other with them very near together; but instead of employing these circuits as two *branch* transmission lines I put them end on, so that they constitute *successive* portions of the same transmission line. An alternating pressure of only 100 volts is provided by the dynamo and applied to the whole arrangement, and yet you observe that, between the going and return conductors in that part of the circuit in which they are far apart, as well as in that part in which they are near together, a pressure exists of 2400 volts, which is twenty-four times as great as the entire pressure supplied by the dynamo to the mains.

This result with alternating electric pressures is not unlike that obtained with mechanical forces when a small force is resolved into two very large ones, with each of which it makes nearly a right angle.

Much damage has been done to electric cables, used for the distribution of power, by these unexpected high pressures produced by resonance in alternate current circuits. A cable may have been tested at twice or thrice the working pressure and passed as satisfactory. But if there is a liability of a pressure being applied, which, as you see, may in somewhat extreme cases be twenty or thirty times the working pressure, what avails it that there is a factor of safety of 2 or 3?—disaster must follow.

Now with direct current for long distance transmission there is no question about the electric pressure at the top and bottom of a wave being much greater than the mean pressure, no question about self-induction reducing the current—no objection, therefore, to putting the conductors as far apart as the risk of brush discharge may necessitate—no question about capacity current, no resonance troubles, &c.

I wonder whether any of you are thinking—Well, perhaps there may be something in this heresy after all. No? Oh! then you are thinking, if the arguments were sound, the direct current system would have been already employed for long distance transmission. Well, but it has! Power up to 3000 horse has been transmitted with direct current, at 14,000 volts, from Combe Garot to Le Locle and La Chaud de Fonds, round a circuit 32 miles long; 4600 horse-power has been transmitted with direct current, at 23,000 volts, 35 miles from St. Maurice to Lausanne; and a transmission system for 6000 horse-power, at 60,000 volts, over 114 miles from Moutiers to Lyons, is in course of construction.

Another advantage that is possessed by all these examples of direct current transmission carried out by M. Thury is that it is the current that is kept constant and the electric pressure that is automatically raised when the demand for power is increased, whereas with the ordinary alternate current system it is the pressure at the lamp end that they aim at keeping constant, and the current that varies automatically with the demand for power

Now it is far more easy to maintain the constancy of the current flowing round a long circuit than to prevent the bobbing up and down of the electric pressure at the distant end of a long transmission line, and that irritating dancing of the lights, with which Johannesburg is so familiar, would be particularly difficult to avoid if the transmission line were long and the electric pressures at its two ends differed by some thousands of volts.

Constant current has also its well known disadvantages, but these would not come into play if the constant current were not taken into houses, mines, &c., but used to drive motor generators in substations, the dynamo portion of the motor generator being of any type desired.

The pioneering development that American boldness, enterprise, initiative, and originality have brought about in the electric distribution of power, combined with the extraordinary commercial success that it has won on both sides of the Atlantic, have made people ask, "Is such an industrial revolution in store for South Africa?"

At first sight one is inclined to answer "No!" This country is dotted with coalfields—coalfields blacken the map, and the produce of some of them is reported to be nearly equal to the best Welsh coal in quality. A humorous English paper said that I was going to give this lecture standing on a coal waggon to indicate how superior, as a carrier of energy, was a coal cart to a current.

When, on the one hand, one hears that good coal is brought from Witbank and delivered to the mines on the Rand at 13*s.* a ton, and that even this price will be lowered on the completion of the new railway from Witbank to Brakpan, one feels that long distance electric distribution has not much chance—indeed, a proposal to burn slack coal at Vereeniging, only 33 miles from Johannesburg, and electrically distribute the power on the Rand, fell through.

On the other hand, when one finds that at the Wankei coalfields themselves large coal costs 15*s.* a ton *at the pit's mouth*, and that Salisbury pays 36*s.* 5*d.*, Umtali 43*s.* 6*d.*, and Kimberley 67*s.* per ton, one feels that electric distribution in this country possesses possibilities.

South Wales has many coal mines—cheap slack coal lies heaped at the pit's mouth. Let me put this question to you: "If an electric supply distributing company were to start in South Wales to obtain their electric energy, *not* from waterfalls, mark you, but from coal brought to their generating stations from coal mines, would you anticipate, I ask, that such a company would obtain customers for their electric energy at coal mines themselves?" "No, emphatically no," you would reply, for that would be taking coals to Newcastle with a vengeance. Yet, what does that map tell us? Why that, within four years since that South Wales company was merely applying to Parliament for an Act to enable them to establish a distribution of power system, fourteen of the largest colliery

companies and thirty of the mines are taking power at about one halfpenny a horse for an hour, the demand three months ago having reached 13,000 horse-power, and rapidly increasing.

That the North-Eastern Railway, and such a large number of manufactories along the Tyne, should, as seen from that other diagram, take power from the Tyneside Electric Power Supply Company—which also has been but four years in existence—was perhaps to be expected, but that coal mines should obtain power by the burning of the product of distant collieries resembles at first sight the method of earning a living attributed to a certain village, viz. by taking in one another's washing.

But this result is but an example of the subdivision of labour. At a coal mine getting coal, and at a gold mine getting gold, is the business, and at both, especially in the early days of sinking the mine, it should pay better to buy electric energy from an outside source than to generate the current on the spot.

Niagara sends 24,000 horse-power to Buffalo, 30 miles away, and sells it at 0.7*d.* per horse-power hour to an eight-hour user there—a price which is *not* cheaper than the total cost of generating a horse-power hour at Buffalo with a *large* steam engine. But tapping electric wires to obtain any amount of power that may be needed, and just at the time that it is required, is far more convenient than erecting steam engines and getting up steam, and certainly cheaper in the early days of sinking a mine.

It has been objected that the total steam-power curves of all the gold mines on the Rand show the same sort of falling-off during the hours 4 to 7 a.m. and 5 to 8 p.m., and, therefore, that, apart from using larger and more economical engines, and from diminishing the cost of superintendence for the energy sent out, there would be no saving by supplying many mines with electric power from a common generating station. But if there be a railway in the neighbourhood, largely used by workmen, the slack hours on the mines will be the busy hours on the railway. Hence, if that railway be run electrically from the same generating station, the load curve will be flattened and much improved.

On the Rand, however, there is an indisposition, apparently, to utilise distribution of power on a large scale. The labour conditions in this country are certainly peculiar. My friend Mr. Denny, in his book on "Deep Level Mines of the Rand and their Future Development," expresses this opinion—and there is no man whose opinions on such matters I value more highly:—"It has, however, been fairly conclusively proved that in average conditions hand labour is both speedier and cheaper than machine drilling."

But when one watches this hand labour one thinks of this picture rather than that. Contrary to American and Australian experience, it may be true that in this country white men and machinery may be dearer and slower than black machinery and man rolled into one. But it makes one uncomfortable, even unhappy, to think it possible, for it means that the muscular machine is more valuable than the inventor's brain.

Another objection felt by mine owners here to investing much capital in machinery is the somewhat uncertain character of their business, and a third against a mine depending for a supply of power on an electric current coming from a distance is the climatic conditions.

South Africa has various unique big things, but it has not a monopoly of big atmospheric disturbances, and these disturbances do not prevent electrical distribution of power schemes being pushed forward by leaps and bounds in the other three quarters of the world—the list given on p. 615 is merely a selection from some of those using the highest working voltages. During my short stay in this country I have been giving this matter much consideration. Without stopping this evening to discuss the subject in detail, I may mention that, after the admirable work of Mr. Wilms, Mr. Spengel, Mr. Heather, and others here on the improvement of lightning arrestors for electric transmission lines, I think I also see my way to putting a nail into the coffin of these bugbear lightning troubles.

But while advocating electric transmission of power I should not start by constructing a transmission line from the Victoria Falls to Johannesburg; and I say that, not because I am of opinion that it could not be made to work, nor that, if direct current were used, it could not be relied on to give as satisfactory results as, or even better results than, some shorter existing ones on the alternate current system, but because it does not appear to me that along the route there is at present sufficient demand for power to justify as large an expenditure of capital as would be compatible with a transmission line 580 miles long as the crow flies, and which would be no less than 745 miles long if made along a railway through Pietersburg and Gwanda, should the missing stretch of railway between these two places ever be constructed.

Those who hold the opposite view will doubtless urge that when the Cataract Construction Company of Niagara acquired in 1890 the right to use 100,000 horse-power, and a further right to use subsequently another 100,000 horse-power, it required an extraordinary belief in the future of electrical engineering to expect that 200,000 horse-power could ever be distributed at a price that could compete with large local steam engines, and they will ask, did not even Mr. George Westinghouse, in 1890, advise Mr. Stetson, the first vice-president of the Cataract Construction Company, that it would only be by compressed air that power could be commercially transmitted from Niagara to Buffalo? And now what is the state of things? Power House No. 1, with ten 5000 horse-power dynamos, has been working for some time, Power House No. 2,* with eleven more 5000 horse-power dynamos, was completed last year. Hence 105,000 horse-power can be developed, and of this 75,000 horse-power is regularly distributed.

Further, the Canadian Niagara Power Company is constructing an electric station of an ultimate capacity of 110,000 horse-power, the Ontario Power Company an electric station, a little lower down, of 200,000 horse-power, and the Toronto Power Company one, a little higher up, of 100,000 horse-power, all these three being on the Canadian side.

Also the Electric and Hydraulic Company, which in 1881 started with a station, on the American side, to supply only 1500 electrical horse-power, has in hand a third station which will bring its plant capacity up to 135,500 electrical horse-power.

Consequently the total electrical horse-power that could be sent out from these various Niagara power houses, when completed, will approach 700,000 horse-power, and represents about 30 per cent. of the water going over the falls at the time of *minimum* flow. But taking into account the further fact that water is already abstracted to feed the Welland Power Canal and the Chicago Drainage Canal, and that other canals are projected, Mr. A. D. Adams has estimated that about 41 per cent. of the minimum flow of Niagara will cease to pass over the falls. In fact, I conclude that *the water that will, in the near future, cease to pass over the Niagara Falls will be nearly five times as large as the total amount passing over the Victoria Falls this month, August.*[1]

The "Thunder of the Waters," the "Cataract of Fearful Height," in America, which have inspired us and our ancestors with reverential awe, may appeal to our descendants as only a vast electric generating station. Very gratifying to us as engineers, extremely distressful to us as lovers of the beautiful.

Now what has caused this vast development in the distribution of power, what is the secret of this extraordinary success? It is that in the immediate neighbourhood of the falls there have grown up works which take some 60,000 horse-power, works which not only want cheap power, but power in an electric form for electro-chemical processes, and need it in an undiminished amount day and night, week-day and Sunday. The Carborundum Company, which manufactures emery's rival grinding material, furnishes an absolutely steady load of 5000 electric horse-power; the Union Carbide Company 15,000, and so on; loads which, from their magnitude and their absolute steadiness, make the electric light engineer's mouth water.

Now what is the prospect of such a steady load growing up locally within, say, 3 miles of your falls? Even

[1] The Resident Commissioner of the Bechuanaland Protectorate, writing to *The Times* from Mafeking the day after the delivery of this lecture, said:—"The volume of water passing over the (Victoria) Falls, was, it is true, infinitely less on August 16, 1905, than on the same date in 1883. It is less to-day than it has ever been in the memory of man."

on the spot it is difficult to obtain trustworthy information; by some it is said that one condition of the contract for the construction of the railway, which is being pushed forward to the copper, lead, and zinc fields at Broken Hill, 400 miles to the north-east, is that 100,000 tons of the ore must be sent to Beira yearly for ten years. If true, then that ore will not be available for reduction at the falls.

There is a convenient spot for a power station near the water at the end of the second gorge—all the Niagara power stations are on the top of the falls, with the exception of those of the Ontario Power Company, and the old Electric and Hydraulic Company—and it is the latter method of construction that would be the most suitable to follow at a Victoria power station.

But jealously guard the beauty of your falls. The protection of the grandeur of their American sister was the underlying idea of Thomas Evershed's hydraulic power scheme of 1886. How little has that object been kept sight of?

Niagara *was* glorious nature, to-day it is power, Victoria is poetry.

FORTHCOMING BOOKS OF SCIENCE.

MR. EDWARD ARNOLD gives notice of:—"The Great Plateau, being an Account of Exploration in Central Tibet, 1903, and of the Gartok Expedition, 1904–1905," by Captain C. G. Rawling, illustrated; "In the Desert," by L. M. Phillipps, illustrated; "Two Years in the Antarctic, being a Narrative of the British National Antarctic Expedition," by Lieut. A. B. Armitage, illustrated; "Common Ailments and their Treatment," by Dr. M. H. Naylor; "Electric Lighting for the Inexperienced," by H. Walter; "Races of Domestic Poultry," by E. Brown, illustrated; "Recent Advances in Physiology," by Drs. A. P. Beddard, L. Hill, F.R.S., J. J. R. Macleod, B. Moore, and M. S. Pembrey; "Valves and Valve Gear Mechanisms," by Prof. W. E. Dalby, illustrated; "Surgical Nursing and the Principles of Surgery for Nurses," by Dr. R. Howard, illustrated; "The Laws of Health," by Dr. D. Nabarro, illustrated; and new editions of "Practical Physiology," by Drs. A. P. Beddard, J. S. Edkins, L. Hill, F.R.S., J. J. R. Macleod, and M. S. Pembrey, illustrated; and "Food and the Principles of Dietetics," by Dr. R. Hutchison, illustrated.

Messrs. Baillière, Tindall and Cox's list includes:—"Psychiatry," by Prof. Bianchi, translated by Dr. J. H. MacDonald; "Manual of Anatomy," by Dr. A. M. Buchanan, illustrated; "Manual of Military Hygiene," by Lieut.-Colonel R. Caldwell, illustrated; "Aids to Surgical Diagnosis," by H. W. Carson; "Sound and Rhythm," by Dr. W. Edmunds, illustrated; "Aids to Pathology," by Dr. W. d'Este Emery; "Trypanosomata and the Trypanosomiases," by A. Laveran and F. Mesnil, translated and edited by Dr. D. Nabarro; "Nodal Fevers," by Dr. A. A. Lendon, illustrated; "Applied Bacteriology," by C. G. Moor and Prof. R. T. Hewlett; "Practical Agricultural Chemistry," by F. Robertson; "Sanitary Science Laboratory Work," by Dr. D. Sommerville, illustrated; and new editions of "Heart Disease, with Special Reference to Prognosis and Treatment," by Sir W. H. Broadbent, Bart., F.R.S., and Dr. J. F. H. Broadbent, illustrated; "Physical Diagnosis," by Dr. R. C. Cabot; "Lectures on Clinical Psychiatry," by Dr. E. Kraepelin, authorised translation revised and edited by Dr. T. Johnstone; "Ambulance Work," by Drs. J. W. and J. Martin; "Manual of the Diseases of the Eye, for Students and Practitioners," by Dr. C. H. May and C. Worth, illustrated; "A Manual of Surgery for Students and Practitioners," by Dr. W. Rose and A. Carless; "The Nature and Treatment of Cancer," by Dr. J. A. Shaw-Mackenzie; "Manual of Physiology, with Practical Exercises," by Dr. G. N. Stewart, illustrated; "The Röntgen Rays in Medical Work," by Dr. D. Walsh, illustrated; and "The Deformities of the Human Foot; with their Treatment," by Drs. W. J. Walsham and W. K. Hughes.

Messrs. George Bell and Sons announce:—"Integral Calculus for Beginners," by A. Lodge; and a new edition of "Elementary Dynamics," by W. M. Baker.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Indian forestry probationers elected last August have come into residence, and the India Office has issued a notice that thirteen more probationers will be selected at the end of October. Candidates must have passed Responsions at Oxford or the previous examination at Cambridge, or some equivalent examination, and will be expected to have some knowledge of chemistry, physics and mechanics, and to be between the age of eighteen and twenty-one years, but the selection board will have the power to relax the superior age limit in the case of candidates who have taken a university degree. Names of intending candidates must be sent to the Under-Secretary of State for India not later than October 26; forms of application can be obtained from Dr. Schlich, 29 Banbury Road, Oxford.

CAMBRIDGE.—The syndicate appointed to consider the desirability of establishing in the university a diploma in forestry is of opinion (1) that a diploma in forestry should be established; (2) that forestry should form the principal subject of the final examination for the diploma; (3) that the diploma should be granted only to graduates of the university; (4) that candidates for the diploma should show evidence of having resided for the equivalent of one year in some recognised centre of instruction in practical forestry. If these recommendations be approved by the senate, the syndicate proposes to draw up and submit to that body detailed regulations for the scope and conduct of the proposed examinations and for the courses of lectures and practical instruction to be required of candidates for the diploma.

At Emmanuel College a studentship of the value of 150*l.* is offered for the encouragement of research in any branch of study recognised by the university. The studentship is open to graduate members of the university whose age does not exceed twenty-eight on January 1, 1906. It is tenable in the first instance for one year from January 1, 1906, but the student may be re-elected for a second period of one year. The latest date for receiving applications is November 20. Further information may be obtained from the master. The student elected is not required to become a member of Emmanuel College.

Mr. J. L. Tuckett, of Trinity College, has been appointed senior demonstrator of physiology until September 29, 1908, and Mr. S. W. Cole, of the same college, will succeed Mr. Tuckett as additional demonstrator in the same subject. Dr. H. B. Roderick, of Emmanuel College, has been re-appointed demonstrator of surgery. Prof. Hopkinson has been elected to represent the board of physics and chemistry on the general board of studies. Mr. J. J. Lister has been re-elected demonstrator of comparative anatomy.

MR. JAMES MILLIKAN, who has given 180,000*l.* for the establishment of a university at Decatur, Ill., which shall bear his name, has offered, we learn from *Science*, to give a further 200,000*l.* to the institution.

A COMMITTEE has been appointed to inquire into the expenditure on public education in England and Wales from Exchequer grants, local rates, and other sources, with the view of ascertaining the various causes for the

existing diversity in the amount of rate levied for education by local authorities, and the varying relation which this amount bears to the total local rates in each area. All the members of the committee are officially connected with the Civil Service.

THE London County Council School of Marine Engineering in High Street, Poplar, has been established to enable

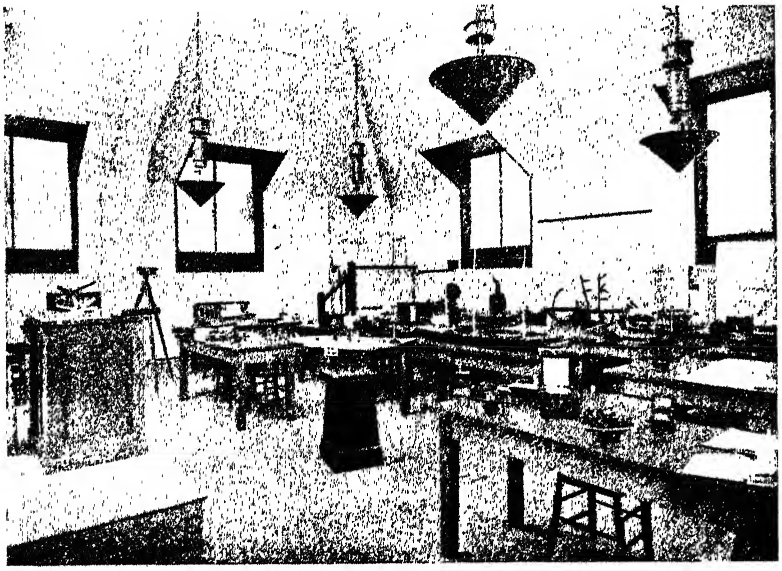

FIG. 1.—Navigation Room of the London County Council School of Marine Engineering, Poplar.

persons in the engineering and shipping industries of the Poplar and neighbouring districts to acquire an intimate knowledge of the principles which underlie the work on which they are engaged, instruction being given in physics, chemistry, and mathematics, as well as in the more practical subjects dealt with in the drawing offices, chart room, and engineering laboratories and workshops. The nautical day school is equipped with modern nautical instruments and seamanship models, and a portion of the roof of the building is arranged so as to form an observing terrace for meteorological and astronomical observations. Provision is also made for the thorough teaching of the principles of electrical engineering, and in the chemical laboratories students have opportunities of making investigations in connection with the calorific value of fuels, methods of purifying feed waters, and other subjects. The accompanying illustration shows the navigation room of the school.

PROF. R. MELDOLA, F.R.S., distributed, on October 11, the prizes and certificates gained during the session 1904–5 by the students of Herold's Institute, the London School of Leather Manufacture. The report of the director of the school, Dr. J. Gordon Parker, was read at the meeting, and showed that during the year a large amount of research work has been done, and the staff of the institute has contributed in no small degree to the important investigation connected with the deterioration of bookbinding leather carried out by the Society of Arts committee on bookbinding leather. Prof. Meldola, replying to a vote of thanks, reminded those present that in other countries there is a direct relationship between technical institutions and the industries. In this country, unfortunately, there is too often indifference or open hostility. Manufacturers have suffered through their unwillingness to modify old procedure and to face new sets of conditions, but it is gratifying to know that hostility to technical instruction is being overcome.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 11.—"On the Cytology of Apogamy and Apospory. —II. Preliminary Note on Apospory." By Miss L. **Digby.** Communicated by Prof. J. B. Farmer, F.R.S.

Apospory is the direct vegetative process which leads from the sporophyte to the gametophyte without the intervention of spores.

The fronds of *Nephrodium pseudo-mas*, Rich., var. *cristata apospora*, Druery, were layered in pans of earth, and soon showed aposporal growth. This arises from the surface and edge of the pinnule, and assumes prothalloid characters. These prothalli have no cushion; the embryo is a vegetative outgrowth.

The nuclear divisions of prothallus and embryo have been studied, and the calculated number of chromosomes is forty-three and forty-one respectively (see Fig.). This approximation undoubtedly proves that there is *no reduction* during the transition from the sporophyte to the gametophyte. A similar result has been obtained in *Athyrium Filix-faemina*, var. *clarissima*, Jones.

The apogamous prothalli of *Nephrodium pseudo-mas*

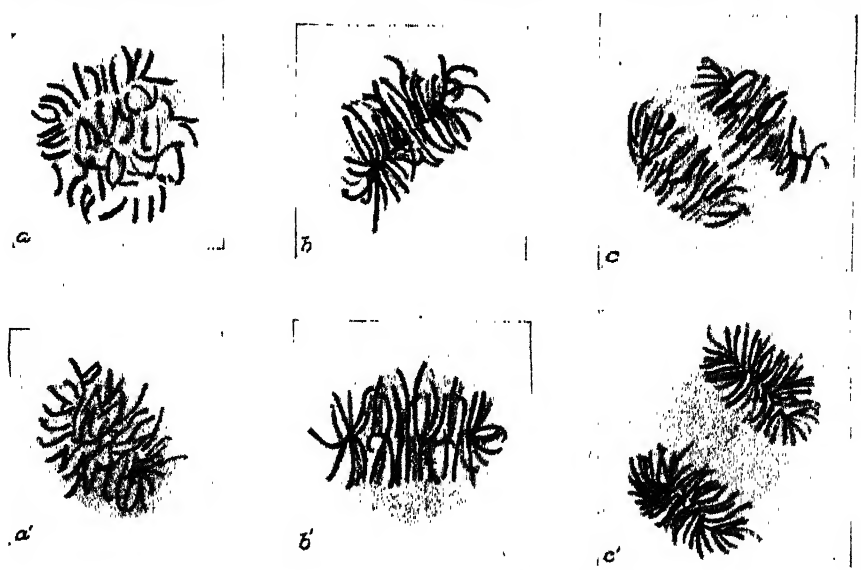

FIG. 1.—Diagrams of nuclear divisions. *a b c* in prothallus. *a' b' c'* in embryo.

cristata apospora show no nuclear migration, whereas about 73 per cent. of those of *Nephrodium pseudo-mas*, Rich., var. *polydactyla*, Wills,[1] exhibit this phenomenon. This is easily explained. Whereas in the former the nuclei of the aposporously developed prothalli have already the full complement of somatic chromosomes, in the latter

[1] J. B. Farmer, J. E. S. Moore, and L. Digby, "Preliminary Note on Apogamy," *Roy. Soc. Proc.*, vol. lxxi., 1903, pp. 453 to 457.

they have only half the number, as the prothalli germinate from spores, the origin of which undoubtedly involves a reduction. Hence the sporophytic number in that case is regained by migration and subsequent fusion of two prothallial nuclei.

MANCHESTER.

Literary and Philosophical Society, October 3.—Sir William H. Bailey, president, in the chair.—Note on the buccal pits of peripatus: C. G. **Hewitt.** A general outline of the characters of peripatus was given. Recently, tracheal structures had been described in an Australian species, *Ooperipatus oviparus,* in connection with the buccal pits. These pits are formed by the hollowing out of the long, chitinous levers which are attached to the inner pair of jaws; they are continuous with the cavity of the mouth. The paper embodied the results of an investigation into the nature of these buccal pits in *Ooperipatus oviparus* and two other species. It was found that tracheæ do not occur in this region of the body, and that the striated muscle fibres which work the jaw-levers had been mistaken for tracheæ.

PARIS.

Academy of Sciences, October 9.—M. Troost in the chair.—The president announced the death of Prof. Baron de Richthofen, correspondant in the section of mineralogy.—Observation of the total eclipse of the sun of August 30 at Alcosebre (Spain): J. **Janssen.** Just before totality the sky was not absolutely clear, a few light clouds interfering somewhat with the photography of the phases, but some minutes before totality the clouds disappeared, and the whole period of totality was studied under the best conditions. Three good photographs of the corona were obtained by M. Pasteur, M. Millochau was able to obtain photographs of the spectrum of the reversing layer and of the corona, and M. Stefanik made ocular observations on the green ray of the corona and of the extreme red. Numerous photographs of the phases were obtained.—On the creation of an international association for solar studies: J. **Janssen.** A *résumé* of the principal resolutions passed at the recent meeting at Oxford.—On the first volume of the "Catalogue photographique du Ciel," published by the Observatory of Bordeaux: M. **Lœwy.** This catalogue contains the rectilinear coordinates of 49,772 stars relating to a zone comprised between +16° and +18° declination. Details of the methods adopted are given, and a special study of the errors has been made.—On the earthquake felt at Stromboli on September 8, and on the present state of the volcano: A. **Lacroix.** The earthquake of September 8, which caused such disasters in Calabria, was also severely felt at Stromboli, as, although no fatalities resulted in the island, there was hardly a building which remained undamaged. Numerous crevasses appeared, some a metre wide and 20 metres long. Some observations were made on the volcano in eruption at a distance of 150 metres from the crater, special attention being given to the times elapsing between the explosions. It would appear that the more violent explosions are not separated from those preceding by an interval of time specially long.—Observation of the total eclipse of the sun, August 30, made at Guelma, Algeria: E. **Stephan.** The work attempted was limited to direct visual observations, which were carried out under excellent atmospheric conditions.—Spectroscopic researches made during the eclipse of the sun, August 30, at Alcosebre (Spain): Milan **Stefanik.** Details of visual observations are given.—On the observation of the total eclipse of August 30, made at Alcosebre (Spain): G. **Millochau.** The scheme of work proposed included the photographic study of the spectra of the reversing layer and the chromosphere in the luminous region, especially in the red, yellow, and green; the spectrum of the corona in the same region; similar researches in the ultra-violet; photographs during totality with plates sensible to the red rays, utilising a red screen to cut off other radiations. Details of the instruments are given, the full discussion of the results being reserved for a later paper.—On the polarised light of the solar corona: J. J. **Landerer.**—Mathematical groups containing several operations of the second order: G. A. **Miller.**—On some derivatives of cyclohexane: P. **Freundler** and E. **Damond.** The starting point of this work was cyclohexanol, prepared by Sabatier and Senderens' method. This was converted into the monobromo- and monoiodo-derivatives by the action of phosphorus bromide and iodide, and rectifying under reduced pressure. These compounds do not, as a rule, give good yields in condensation with sodium derivatives, an exception being in the reaction with sodiomalonic ester, the yield in this case being 27 per cent.—On the decomposition of meta- and para-nitrobenzylic alcohols under the influence of aqueous and alcoholic soda: P. **Carré.**—On some phenolic ethers with the pseudo-allyl chain $ArC(CH_3)=CH_2$: MM. **Béhal** and **Tiffeneau.**—On sambunigrin, a new hydrocyanic glucoside extracted from the leaves of the black elder: Em. **Bourquelot** and Em. **Danjou.** The existence of this glucoside has been indicated in a previous note, and in the present communication details are given of the method by which the sambunigrin has been obtained in a pure state. The new glucoside appears to be isomeric with the amygdonitrile glucoside of Fischer, from which it differs in its rotatory power.—Statistical researches on the evolution of the size of plants: Mlle. **Stefanowska.** The results are expressed in the form of curves.—Study of the blood in the case of a "bleeder": P. Émile **Weil.** Numerous experiments have been made on the coagulation of the blood from this case. The most important result obtained was the observation that the anomalous coagulation in these cases is not due to the presence of any anti-coagulating substances in the blood, but arises from the absence or alteration of certain normal substances, probably the coagulating ferment. It is sufficient to add traces of normal serum to cause a normal coagulation.—On the direct proofs of the existence of counter trade winds: Lawrence **Rotch** and Léon Teisserenc **de Bort.**

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THURSDAY, OCTOBER 26, 1905.

THE STUDY OF FISHES.

A Guide to the Study of Fishes. By David Starr Jordan. Vol. i., pp. xxvi+623; vol. ii., pp. xxii+599; with coloured frontispieces and 427 illustrations. (New York: H. Holt and Co., 1905.) Price 40s.

THIS beautiful work naturally invites comparison with the recently published seventh volume of the "Cambridge Natural History." Both actually cover the same ground, since both contain also an account of those invertebrates which, like Balanoglossus, Tunicates, and Amphioxus, claim the ambitious honour of a more or less direct ancestral position to the fishes.

It has been objected that the anatomical treatment, although good, exact, and up to date, takes too much space of the Cambridge volume, to the detriment of those more œcological questions which are of more general interest, and are, after all, as important as the structural detail, because they make up the life of the fish. The systematic account of the Teleostei, containing Boulenger's new classification, forms the main feature, rather stern, only here and there relieved by some interesting and little known information about habits, showing that want of space, not disinclination, has guided the author.

The author, who is president of the young and vigorous University at Palo Alto, in beautiful and exhilarating California, proceeds nominally upon the same plan, but its execution is totally different. With him the fish is alive, even the fossil. Having travelled much, he has fished with the Japanese, trawled in the vast Pacific, and the huge continent of North America is his special domain. He has collected much, and has observed more "in the good company of the woods and brooks."

"The man who kills all the trout he can, to boast of his skill or fortune, is technically known as a trout-hog. Ethically it is better to lie about your great catches of fine fishes than to make them. For most anglers, also, it is more easy."

The first volume begins with a popular account of the life of the long-eared sunfish. What is a fish? What is it like, and so unlike, to everything else? How does it breathe, see, move, adapt its coloration, and how does it breed? After we have caught it, and observed it in an aquarium, it is dissected, and the student is introduced to the morphology from a general point of view. The account which follows is neither stiff nor anything like exhaustive, but in about 100 pages enough is said to help the intending ichthyologist to an appreciation of the taxonomic importance of ichthyotomy and its salient problems. Many of our fundamental questions of vertebrate morphology find their solution in the fishes. The author devotes a whole and long chapter to the morphology of the fins, with a clear exposition of the vexed controversy whether the pectoral limb has arisen from a problematic lateral skin fold or from an organ like a gillarch, which already did exist, and required but a slight change of shape and function. The organs of respiration lead to a summary of the present state of our knowledge concerning air-bladder and lungs; the other organic systems follow suit. What the author has to tell us are all points which, although they can be studied elsewhere, could not well be omitted from such a work.

Not so chapters x. to xx. Postembryonic development, with the often most peculiar larval forms; instincts, habits and adaptations afford a rich field of observation, graphically described, with admirable illustrations. Witness the photograph of the tens of thousands of fishes which, having run up-stream to spawn after a rain, are left stranded by the falling water.

Protection by the spines, by the poisonous nature of the flesh, electric batteries, luminous organs, quaint nursing habits, are, of course, the stock in trade of any book on fishes. The angling apparatus of Lophius is such a feature, but it is not often that it is treated as follows:—

"In the large group of angler-fishes the first spine of the dorsal fin is modified into a sort of bait to attract smaller fishes into the spacious mouth below. This structure is typical in Lophius, where the fleshy tip of this spine hangs over the great mouth, the huge fish lying at the bottom apparently inanimate as a stone. In other related fishes this spine has different forms, being often reduced to a vestige, of little value as a lure, but retained in accordance with the law of heredity. In a deep-sea angler the bait is enlarged, provided with fleshy streamers and a luminous body which serves to attract small fishes in the depths. The forms and uses of this spine in this group constitute a very suggestive chapter in the study of specialisation and ultimate degradation, when the typical function is not needed or becomes ineffective."

This is truly observation and reflection combined, and the rendering of it is that of a thorough evolutionist who is in sympathy with his favourite class of creatures.

The colour of fishes is another fertile field, with sexual, nuptial, and protective changes. Perhaps in order to curb the ardour of those who see some special good or purpose in every pattern or colour, we are told that the brilliantly coloured fishes of the tropical coral reefs have no need of protective coloration.

The chapters on geographical distribution might well form an essay by themselves, since in them are interwoven lessons of natural selection, the effects of temperature, agencies of oceanic currents, the effects of the direction of coast-lines, and last, not least, the separation of faunas by isthmus barriers, notably those of Suez and Panama. Their far-reaching results are explained by an analysis of the Japanese fish-fauna in comparison with that of the Mediterranean and Central American waters. But whilst the methods of marine distribution and their final results are relatively simple, the fresh-water fishes provide stiffer problems, and some forty pages are therefore devoted to the ways and means, successes and failures, as exemplified in detail by the fauna of the North American continent. This makes fine and admirable reading, but it also shows the value, scien-

tific and practical, of well directed boards and commissions of agriculture and fisheries.

A long chapter on the history of ichthyology, enlivened by the photographic reproductions of several dozen of the more prominent workers in this field, and a chapter on the evolution of fishes since Ordovician times, bring us to the systematic part, which comprises the last quarter of the first and the whole of the second volume.

Here we have to find fault. There is no thorough classification or system. The table of contents of the chapters makes matters only worse. A single page with an outline of the arrangement would be a boon. The author is well aware of the uncertainty of the position of many of the groups, or of their claim to being natural assemblies at all. He never fails to point out how they may be supposed to be connected with each other, or that they are side branches of the ideal tree, but he too often assigns to his groups values or rank without reference to the next higher category of which they are meant to form part. The result of this treatment is bewildering to the reader unless he studies the whole work and abstracts from the many hints given a system of his own; and in this respect the book is truly a "Guide to the Study of Fishes," and not a categorical text-book.

The terms subclass, series, order, subdivision, are often used promiscuously, sometimes as a heading which differs in its meaning from that assigned to it further on.

This being a case of fault-finding, a matter of regret with a work which is otherwise so well done, so full of information, and opening out so many new vistas, let the reader try whether he can abstract from it a co- and sub-ordinated systematic arrangement.

However, perhaps the author did not intend to give a rounded-off classification. In many respects his views differ from Boulenger's system, and it may well be asked whether there is a single class of animals about the grouping of which there is general consensus. Leaving, therefore, this point, we cannot but admire the masterly manner in which the enormous class of fishes, recent and extinct, has been marshalled. Group after group is diagnosed, reviewed, discussed, figured, and endowed with never flagging interest.

"And with these dainty freaks of the sea, the result of centuries of centuries of specialisation, degeneration and adaptation, we close the long roll-call of the fishes." H. G.

THE FAR EAST.

The Far East. By Archibald Little. Pp. viii+334. (London: Frowde, 1905.) Price 7s. 6d.

OF late years the Far East is only far in actual distance; it is very near to our thoughts, while the ignorance regarding these lands is being very rapidly dispelled. At the present moment it is Japan that is attracting our attention; five years ago it was China, and probably in a few more years, now that the Russo-Japanese contest is concluded, China will again be the centre of interest. In his most interesting book, "The Far East," Mr. Archibald Little devotes more space to China than to Japan, having been himself for very many years a resident of the former country, and possessing a knowledge of the Chinese surpassed by no one. China stands now at the parting of the ways; for many years resolute in keeping out foreign inventions so distasteful to the old-fashioned mandarin, circumstances have proved too strong, and railways, the precursors of western life, are now being built or projected throughout the land. No one can foresee what changes twenty years will bring about in this vast country, a vastness which Mr. Little brings home to us by his diagrams and comparative tables.

To a lover of things historical, nothing can be more fascinating than to wander back through the long centuries to some thousands of years before the Christian era; and this it is necessary to do if one would study Chinese history. To compress this into a volume of reasonable size and yet to give a comprehensive account of each province is a difficult task, but Mr. Little's apology in his preface is unnecessary.

China naturally lends itself to the division, which is carried out in this book, into the northern, middle, and southern basins, with the four dependencies of Manchuria, Mongolia, Turkestan, and Tibet. Of these four dependencies, it is in Mongolia and Turkestan only that Chinese rule may be considered as firmly established; in Tibet the amount of power in the hands of the Chinese depends on the personal characteristics of the Tibetan Dalai Lama and Regent and the Chinese Amban; undoubtedly one result of Younghusband's mission to Lhasa has been to emphasise Chinese authority in the eyes of the Tibetans. Of Manchuria at the present moment it is unsafe to hazard an opinion, but everything points to its becoming once more a Chinese possession under possibly Japanese moral tutelage. A consideration of the two chapters on "Whilom Dependencies" leads naturally to a thought of how of late years the more outlying dependencies have been gradually lopped off, how the once mighty Chinese Empire has degenerated. Cochin China, Annam, Corea, as well as Burma (which does not enter into the scope of this book), all once paid tribute to China.

Siam, for many years in danger of being squeezed out of existence between two European Powers, has taken a new lease of life, and is now in a more prosperous condition than it has been for many years.

Japan might have many chapters written about it, but we have been lately so inundated with things Japanese that it is almost with a feeling of relief that we turn once more to the chapters on China itself. We would, in truth, most warmly recommend this book to anyone about to travel in the Far East, as well as to the stay-at-home reader, more particularly as regards China.

Take the northern basin. What more interesting to read about than Peking itself; Shansi, the province of coal and iron; Shantung, where the Germans at great cost are slowly developing their trade through Kiao Chau? What great river in the world has

changed its course as the Yellow River has? What other country in the world has built a Great Wall? We are accustomed to hear much of the peculation of the officials, but Mr. Little does not emphasise this; in many districts the officials are revered and beloved by the people.

Consider the Yangtse Valley, again, where ocean steamers can reach Hankow, where steamers with Mr. Little himself as their pioneer have reached to Chung King, and lately still further. This magnificent river will undoubtedly remain the great high road for commerce into Central China; but railways are and will be built to act as feeders to the main line, much to the profit of the shareholders and of the inhabitants, for Chinese are born traders, and already make use of the pioneer of Chinese railways—the line from Tientsin to Peking—in large numbers.

Finally, we have a vivid description of the southern basin, Canton, Hong Kong, and the provinces bordering on French territory. Yunnan, which adjoins our Burma, has a particular interest to Englishmen; but here, owing to our supineness in days gone by, we have allowed the French to get ahead of us with their railway, which will undoubtedly draw to itself all that is valuable of the trade of the province.

There was a time when many people thought that China would be divided among the Great Powers—that notion is exploded; then came that of spheres of influence—but we have seen this idea also put aside; the policy of the "open door" is all that remains.

We congratulate Mr. Little on having given us a most readable volume, full of information, and yet with that local colouring which is an essential for a book to command the attention of the general reading public.

ABSORPTION SPECTRA.

Handbuch der Spectroscopie. By Prof. H. Kayser. Vol. iii. Pp. viii+604. (Leipzig: S. Hirzel, 1905.)

WHEN Prof. Kayser published the first volume of his "Handbuch der Spectroscopie," he said that the third volume would be devoted to absorption spectra and cognate phenomena. He has, however, found it necessary to treat the subject in two volumes, the first of which contains the methods of investigation of absorption spectra, the variability of absorption, the connection between absorption and chemical constitution, and, finally, a list of all the measurements of the absorption spectra of inorganic and artificial organic substances. In the next volume the absorption of the natural colouring matters in the animal and vegetable kingdom will be described, together with the relation of dispersion and fluorescence to absorption and, lastly, phosphorescence. The present volume is peculiarly interesting, as it deals to a great extent with the application of spectroscopy to chemical and physicochemical problems.

In the first chapter Prof. Kayser deals with the apparatus and methods of investigation of absorption, and includes a discussion upon the nature and laws of absorption. It is well known that considerable confusion exists with regard to the terms used by various experimenters, as, for example, absorption-coefficient, &c. Not the least important section of this chapter is that in which the author discusses these and proposes a uniform set of definitions upon a proper physical basis. In the discussion of the nature of absorption, Prof. Kayser is perhaps a little obscure. He very properly divides absorption into two kinds, namely, the ordinary kind for which Kirchhoff's law holds, and the so-called metallic reflection for which the law does not hold. On p. 9 Prof. Kayser says, in referring to those bodies which show surface colour, *i.e.* metallic reflection, that these bodies show well-marked absorption bands, and that the particular rays are wanting in the transmitted light, not so much because they are strongly absorbed, but because they are strongly reflected. This statement is rather misleading. The phenomenon of metallic reflection is shown by two classes of bodies, firstly, the metals which are perfect conductors, and, secondly, those substances which show surface colour and are not conductors, as, for example, the aniline dyes. Prof. Kayser's remarks, strictly speaking, only apply to the first group, *i.e.* the metals, because as these bodies are conductors the light cannot penetrate below the surface. In the case of the substances belonging to the second group the mechanism must be somewhat different. When a moderately dilute solution of an aniline dye, such as rosaniline, is examined by transmitted light, a very strong absorption band is developed in the green. No surface colour is visible, and undoubtedly the disappearance of the green rays is due to the absorption of these rays by the molecules of the dye. On the theory of resonance, the dye molecules vibrate in sympathy with the green rays and scatter the incident energy. If now the solution is concentrated, the absorption on the surface becomes greater, that is to say, the number of resonating molecules in the surface is increased, until eventually the scattering of the light becomes visible, and we have the surface colour of the same wave-length as the absorption band. It is not accurate to say that the light is reflected rather than absorbed, because in dilute solutions the rays penetrate to a considerable distance before being absorbed.

In the second chapter Prof. Kayser deals with the variation in the absorption spectra of substances with variation in the external conditions. Here he points out that the extraordinary changes undergone by absorbing substances with changes in the solvent, dilution, &c., show clearly what a mass of useless work on absorption spectra has been published owing to the observations having been made under very limited conditions. The most interesting section of this chapter is that in which the variations of the absorption spectra of coloured metallic salts with dilution change are discussed. A great many observations have been made by Ostwald and others upon the absorption of coloured salts and the results published in support of the ionic theory. Unfortunately, more recent experiments have shown that the absorption by the different salts of the same metal and that by the different salts of the same acid show small

but perfectly regular differences. The position of the absorption bands varies with the mass of the colourless ion, and certain other facts have been observed of the same character. Prof. Kayser reviews most carefully the whole of the evidence of absorption spectra that has been brought forward both for and against the ionic hypothesis; he finally concludes that Ostwald's theory, namely, that the behaviour of dilute aqueous solutions of coloured metallic salts is due to the colour of the ions, is untenable. Such an authoritative statement, based on experimental evidence, is very striking and worthy of careful consideration by physical chemists.

The third chapter has been written by Prof. Hartley, and deals with the relation between absorption and chemical constitution. It contains an excellent *résumé* of all the work which has been carried out, chiefly by Prof. Hartley himself, on the bearing of ultra-violet absorption to molecular structure. The value of this work is too well known to need emphasising here, and it is not too much to say that this is one of the most important branches of spectroscopy, and one that is certain to lead to results of far-reaching importance in organic chemistry.

The two last chapters deal in detail with absorption spectra; in the fourth chapter are described the spectra of many substances, selected either because they are of some practical use, or because they possess some special point of interest, while the fifth and last chapter contains an alphabetical list of all substances the absorption of which has been measured.

Of the great value of this book it is impossible to speak too highly; it is sufficient to say that it will rank as the standard work upon absorption. All who read it will appreciate to the full the great care Prof. Kayser has bestowed upon it and the immense labour involved in dealing with the mass of literature upon the subject.

E. C. C. B.

OUR BOOK SHELF.

Identification por las Impresiones digito-palmares (La Dactiloscopia). By Dr. Alberto Yvert. Pp. 111. (La Plata: A. Gasperini, 1905.)

THIS work is the thesis presented by the author to the University of Lyons in order to obtain a doctor's degree in medicine. It deals, firstly, with the uses to which identification by means of finger-prints can be put by the detective, and shows how the fingers of the murderer leave their impression printed in the blood of his victim; while those of the burglar may be brought to light on the window through which he has passed, by the simple expedient of breathing on it, and may be indelibly recorded by means of hydrofluoric acid; and, lastly, the finger-marks of the forger may be revealed on the cheque which he has forged, by means of Mr. Forgeot's method. This last record is produced, first, by the sweat of the fingers that rest on the paper, which, when it evaporates, leaves an invisible print behind it in the salts which were contained in it. This may be made to appear by the application of an 8 per cent. solution of nitrate of platinum, which is affected by these salts in such a way that it blackens when exposed to light.

The author proceeds subsequently to the most important part of his work—a summary of the principal methods of classification of finger-prints. He commences with a somewhat inadequate description of the original system, which, as is well known, is that of Francis Galton; he then goes on to treat with much fuller detail some of the various systems which are based on it. Among these are included that of M. E. K. Henry, which has been adopted by M. Windt, chief of the Identification Service of the Police in Vienna; that of M. Pottecher, chief of the Immigration and Identification Service in Saigon; and of Señor Vucetich, director of the Identification Service in La Plata. It is the last system which is preferred by the author. It consists in dividing all finger-prints into four types, which he names as follows:—(1) *Arco* = arch; (2) *Presilla interna* = internal loop; (3) *Presilla externa* = external loop; (4) *Verticilo* or *Torbellino* = spiral. These terms are descriptive of the figures formed by the lines situated near the centre of the palmar surface of the distal phalanx of each digit. As all ten fingers are taken into account in the classification, and as each may be of any of the above four types, there are 4^{10} (= 1,048,576) classes defined in this way. The minute details of the arrangement enable one to distinguish between different members of the same class.

The pamphlet concludes with a useful bibliography.

E. H. J. S.

Science in South Africa: a Handbook and Review. Prepared under the auspices of the South African Governments and the South African Association for the Advancement of Science. Edited by the Rev. W. Flint and J. D. F. Gilchrist. Pp. x+489. (Cape Town, Pretoria, and Bulawayo: T. Maskew Miller, 1905.)

THOSE members of the British Association who were fortunate enough to visit South Africa this year cannot fail to have benefited by this useful and handsome volume. To those who were unable to accompany the association, but who take an interest in scientific work in South Africa, this "index book" will be a great boon. Of late years, South African scientific literature has increased at a great rate, but the material frequently lies scattered in numerous publications often difficult of access, while so many divergent opinions on the same subject have been expressed that the student is apt to be bewildered. From the present volume the *status quo* of scientific research in South Africa can be ascertained. A long-felt want is thus supplied, and if the scientific literature is to increase at the same rate in the future as it has in the immediate past, a year-book on similar lines would be of inestimable value.

The cost of publication of the present volume has been defrayed by the various South African Governments. In doing this they betray an enlightened policy, for there can be no question that it will direct attention to the vital importance of scientific knowledge in a country so vicariously treated by nature as South Africa, where the natural products are distributed in such a way that they can only be utilised by the application of the discoveries of modern science. To those so trained, South Africa becomes a land of fertile promise.

The present volume is arranged in eight sections, dealing with physical, anthropological, zoological, botanical, geological, mineralogical, economic, educational, and historical problems. The sections and subsections are the voluntary contributions of actual workers, to whom the editors have allowed considerable latitude as to the method of treatment. In some cases the subjects are dealt with historically, in others from the practical point of view. The volume contains numerous illustrations, among which

the handsome coloured plates of blue ground and diamonds of various shapes and colours, presented by Mr. Gardner Williams, stand out conspicuously.

While it is evident that much has been achieved, it is equally certain that in some branches only a start has been made. In fact, the dominant feeling produced by reading the several interesting articles is one that should inspire the greatest hope and enthusiasm among scientific students in this country and throughout South Africa. Here lie new worlds of unknown possibilities. As yet we stand only on the threshold. Far off glimpses of a wonderful country have been obtained, but it is the sight of a Kilimanjaro enshrouded in mist, not of the unclouded mighty mountain-mass. W. G.

Stone Gardens. By Rose Haig Thomas. Pp. xii and plates. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1905.)

AN old wall sheltering such plants as are accommodating enough to grow in such a situation is often a delight; but to undertake the formation of a "stone-garden" in the way suggested by the author is to run counter to all our notions of the amenity and purpose of a garden. Various "designs" are offered for adoption, such as a lyre-shaped outline made of paving stones with flower-beds representing the strings, and separated by narrow strips of stone.

Another design shows three snakes intertwined, each snake made of flat stones of a different tint from its neighbour. The spaces between the serpentine convolutions are filled in with flower-beds. Other designs are more appropriate to a formal or architectural garden.

Of course, there is no disputing upon points of taste, and each garden-lover must exercise his or her fancies according to circumstances and in obedience to individual proclivity. But if the designer intends to furnish a model for other people to adopt, then we expect there will be comparatively few garden-lovers who will share the author's taste or feel inclined to adopt her suggestions.

Be this as it may, the author gives very clear directions as to how her designs should be carried out, and very judicious instructions as to the plants to be selected and the method of planting them. Provided these be properly carried out, kindly nature will do her best to conceal the flags and stones, and if the author's designs are somewhat interfered with in the process, that will not be a matter for regret on the part of most garden-lovers. The work is in quarto, with fourteen designs in colour.

Oblique and Isometric Projection. By John Watson. Pp. iv+59. (London: Edward Arnold, n.d.) Price 3s. 6d.

IN defining the forms and dimensions of solids by means of scale drawings, a very useful method in certain cases is that of metric projection whereby three systems of parallel edges of the solid are represented on paper by lines parallel to three axes drawn in arbitrarily selected directions, and to any three scales also independently chosen. The author deals only with isometric projection, and considers two cases, first, when the projection is orthogonal, secondly, when the projectors are oblique with the plane of projection taken parallel to a face of the solid, so that figures parallel to this face appear without distortion. The best part of the book is probably the chapter giving examples, mostly of joints in woodwork, used by the author in conducting classes in manual training; but it is doubtful whether it was worth while to publish a book of such limited scope.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Eclipse Phenomena.

No opportunity for discussion was given at the Royal Society meeting last Thursday, but the following brief notes may be suggestive and possibly useful.

The particles in the corona which reflect solar light to us are presumably moving very fast away from the sun, and accordingly are illuminated by light of apparently extra-long wave-length. This light, thus lowered in refrangibility, they will emit; and inasmuch as they are probably moving at all sorts of speeds, we might expect that Fraunhofer lines would be encroached upon and blotted out from the resulting emission, especially as some particles would have a component of velocity towards us and others away from us.

If any of the particles are emitted with anything like the speed of some of those from radium, the maximum change of frequency to be expected would be great.

Particles illuminated by rays normal to our line of sight will send us a plane polarised beam, but when the illuminating rays are oblique to the line of sight, as may be the case from some of the longer streamers, then the polarisation would be only partial.

How far single electrons may be able to resist the forced vibrations of light-waves, and thus become themselves polarised sources, is a matter on which I hope to try some experiments. The illumination in which they are immersed near the sun is very intense.

The circular or ring appearance seen in the midst of the corona in some photographs, with geometric centre at a distance from the apparent centre of explosion, looked to me like a gigantic vortex ring. I see no reason why a sun-spot should not eject such rings occasionally.

OLIVER LODGE.

Geometry of Position.

IN connection with the review of Mr. Wilson's recent book, on p. vi. of your supplement last week, may I direct the friendly attention of the reviewer and your readers to an old paper of mine in the *Philosophical Magazine* for November, 1875, where some of the theorems referred to are given. I myself have found a slight modification of the rapid system of writing chemical formulæ there advocated, extremely useful, and should like to advocate its use by elementary students of organic chemistry—but that is another matter. OLIVER LODGE.

October 20.

Eclipse Predictions.

THE discrepancies referred to by Mr. J. Y. Buchanan (p. 603) as existing between the French and British predictions for the recent total eclipse of the sun are due simply to the fact that a different value of the moon's diameter is adopted in the Connaissance des Temps from that in the Nautical Almanac, the former being about $2''\cdot7$ greater than the latter. Hence the breadth of the zone of totality and the duration of totality on the central line are greater in the French than they are in the British ephemeris. But there is no occasion to impute mistake to the French calculators. They merely assume a value of the moon's diameter that is, in my opinion, too large for eclipse purposes. A. M. W. DOWNING.

October 20.

Chelifers and House-flies.

IT may be that the view suggested in my letter to NATURE of August 31, that the association of the Chelifer with the house-fly is to the advantage of the former in providing it with a wider geographical distribution, is not sound. I believe it is, but at the same time admit that there is not sufficient evidence at present to prove that the association is of material advantage to the species.

The important point to determine, however, is whether

the Chelifer is or is not a parasite on the house-fly. It is fully recognised now that house-flies play an important part in the distribution of the germs of certain diseases that affect mankind. Any animal, therefore, that injures or destroys the flies may assist in checking the spread of disease. But if, as Mr. Pocock suggests, the object of the Chelifer is to feed upon the acarine parasites of its host, it serves rather as a friend than a foe to the fly, and should certainly not be called a parasite.

There is no anatomical reason for believing that the Chelifers that have been found on flying insects are specially adapted to a parasitic mode of life, nor is there any evidence that the house-flies they are attached to are infested with mites or any other skin parasites. If the Chelifers are not parasitic on the flies, and there are no mites for them to attack, how can the association of the two forms be accounted for otherwise than by the transportation hypothesis?

Since I wrote my last letter to you I have found that this matter has been most fully discussed by Mr. Kew in his article on Lincolnshire Pseudoscorpions in the *Naturalist* for July, 1901, and I would refer readers of NATURE who are interested in the subject to that paper for fuller particulars. SYDNEY J. HICKSON.

University of Manchester, October 21.

The Rudimentary Hind Limbs of the Boine Snakes.

IT is a well known fact that the pythons and boas and some allied forms among snakes possess rudiments of hind limbs, these vestiges—to quote Boulenger's "Catalogue of Snakes in the British Museum"—"usually terminating in a claw-like spur visible on each side of the vent." These structures are always mentioned in general works upon Ophidia, such as Hoffmann's account of the serpents in vol. vi. of Bronn's "Klassen und Ordnungen des Thierreichs," and Gadow's "Reptiles and Amphibians" in the "Cambridge Natural History." But in none of the three treatises to which I refer is there any further account of the "claws" or "spurs." It is merely stated that they are present. It is not mentioned in these works, nor in some others which I have consulted, that the claws in question offer valuable sexual characters by the aid of which individuals can be referred to their proper sex, at least in certain Boidæ. The fact that these characters have been so largely overlooked is perhaps due to the slight stress laid upon them by Duméril and Bibron (*Erpétologie Générale*, vol. vi., 1844), who, however, did direct attention to the occurrence of differences in these organs between the two sexes in a number of Boidæ. But they speak of the claws merely as being "d'une très petite dimension chez des femelles," and as "plus développés chez les males que chez les femelles." The first of these quotations refers to Eunectes, the second to Boa. The differences, however, in *Eunectes notaeus* are greater. In this southern anaconda, of which several specimens were lately deposited in these gardens by the Hon. Walter Rothschild, there is in the male a sharp curved claw turned downwards and ridged along its lower surface. In the female, on the other hand, the representative of this claw is not a claw at all strictly speaking—if, that is to say, we mean by a claw a nail-like structure which is curved and compressed and ends in a sharp point. In the female there is a straight, blunt, horny process distinctly unlike the sharp claw of the male. In two young examples of this anaconda, which are females, the same type of horny structure is found as in the adult female. In the allied genus Eryx there are still greater differences between the two sexes. FRANK E. BEDDARD.

Zoological Society's Gardens, October 18.

A Rare Game Bird.

MR. SAWBRIDGE (p. 605) has raised one of the most perplexing points connected with bird-migration. I cannot answer for the eastern counties of England, but here, in the south-west of Scotland, we are still further from the headquarters of the quail than he is. Fifty years ago quails bred regularly in western Galloway; as a boy I recollect that two or three brace were quite a common complement to a September bag. Indeed, when a "cheeper" or undersized partridge was shot, "Put it down as a quail!" was the usual comment. These birds gradually disappeared; the last that I myself shot was about the year 1868; but an odd one has been obtained here and there in the district ever since. One, I know, was shot last month in the neighbourhood of Newton Stewart, and was reckoned such a curiosity that it was sent to the bird-stuffer. I am sorry that I do not know whether it was a young or an old bird. Besides this, other instances, if I mistake not, have been recorded in the *Field* from different parts of the country.

As to the cause of the general disappearance of quails from this district, there have been many speculations, the commonest notion being that the supply is so heavily taxed in the Mediterranean region that few birds escape to the north. Truly, when one considers the enormous consignments of quails to London, Paris, &c., there is no reason for surprise that the migrants should dwindle in number.

I have a vague recollection of being told in boyhood that about the year 1838 there was a large influx of quails into Galloway, and that they had bred there ever since, but in numbers annually decreasing. It is conceivable that a storm-driven flock may have been carried out of their bearings, and, finding food abundant and climate endurable, if not altogether congenial, remained as colonists, but that our wet summers have proved adverse to their young being reared. The fluctuation in the stock of partridges caused by the character of different seasons is very remarkable, and evidently neither the numbers nor the constitution of our quails have enabled them to survive adverse conditions of temperature and rainfall. This makes the sporadic occurrence of individuals at long intervals all the more remarkable and perplexing.

HERBERT MAXWELL.

Monreith, Wigtownshire, October 22.

On a New Species of Guenon from the Cameroons.

A CHARMINGLY docile species of guenon, obtained by Cross, of Liverpool, from the Cameroons, in West Africa, and recently submitted to me for identification proves to be undescribed. I propose for it the name *Cercopithecus crossi*, in compliment to the courteous proprietor of that large and well known importing house of wild animals, and for popular use the name of *Cross's guenon*. The animal is a male, apparently nearly full grown, but not entirely adult, as the condition of its teeth indicate. It is very similar to *C. moloneyi* of Sclater, in general appearance, in having the broad rufous lower back, but differs in having a large and bushy pure white beard, white throat, and bushy whiskers of black hairs ringed with white; the band across the forehead deep black instead of fulvous; sides of head speckled black and white; underside of body sooty-black speckled with white; the tail not deep black except at tip, but speckled black and white like the upper part of the back; the black on the forearm externally does not extend to the shoulder, and not much beyond the elbow; the outer aspect of thighs is black slightly peppered with white; the inside of arms below the elbow black, higher up sooty-grey; inside of hind limbs sooty-black.

The top of the head is black, the hairs sparsely ringed with white; the face, cheeks, and ears quite nude and purplish black in colour; long superciliary hairs are present; the callosities are small and purplish sooty-grey in colour.

From *C. albigularis* (Sykes's guenon) the present species differs in wanting the yellowish wash on shoulders, fore and hind limbs, and in having a brindled and not a black tail. HENRY O. FORBES.

The Museums, Liverpool, October 12.

The Absorption Spectrum of Benzene in the Ultra-violet Region.

WE were glad to see in NATURE of October 5 a letter from Prof. Hartley in which he points out the near agreement between our measurements of the bands in the absorption spectrum of benzene and those made by Prof. Dobbie and himself. He also directs attention to the work of Friederichs, who, in the case of benzene vapour,

finds the position of these bands to be consistently nearer to the red end of the spectrum. The difference in the position of the bands in the spectrum of benzene vapour and of benzene in solution only proves, of course, the applicability of Kundt's rule. We are also pleased that Prof. Hartley has been able to see the second band on our list ($\lambda=2656$), which, coupled with the fact that Friederichs has also measured it, we feel is a most important confirmation of our observations.

As regards the eighth band ($\lambda=2330$) which has been measured in the absorption spectrum of benzene vapour by Friederichs (whose work we were, of course, unaware of when we wrote our paper), we have made a most careful search for it. We have re-examined our original plates and have taken several more photographs, but have been unable to find any trace of it. We must therefore conclude that it is absent from the spectrum of benzene in alcoholic solution.

There is one other point in Prof. Hartley's letter; he says we have overlooked some points of importance in his paper with Prof. Dobbie when we state that they only found six bands. It is quite true that in their paper Hartley and Dobbie refer in their table of measurements to another band of very short persistence which they mark as doubtful at 5 mm. thickness of N/10 solution, and very doubtful at 4 mm. thickness. In the letterpress, however, they speak of only *six* bands, and in all later publications benzene is stated to show six absorption bands. In the British Association report, and even in Prof. Hartley's paper to the Chemical Society on May 17 of this year, he speaks of six bands (*Chem. Soc. Proc.*, xxi., 167). We therefore assumed that Prof. Hartley, on further consideration, had concluded that this doubtful band was not a true benzene absorption band. As we ourselves had seen no trace of this band, we in our paper before the Chemical Society (*Trans. Chem. Soc.*, lxxxvii., 1332) stated that Hartley and Dobbie had found only six bands.

Prof. Hartley's ideas and work upon the absorption spectra of organic compounds in the ultra-violet are of the greatest importance; he was the first to show how the constitution of certain compounds could be established by this means. Prof. Hartley's method of "testing" a molecule by means of its absorption spectrum, we are sure, will prove of the greatest possible value in the hands of chemists.

E. C. C. BALY.
J. NORMAN COLLIE.

University College, October 12.

Action of Radium Salts on Gelatin.

HAVING occasion to give a demonstration of the properties of radium some little time ago, I determined to attempt the preparation of some of the organisms as described by Mr. J. Butler Burke.

The method employed was to sprinkle a few specks of the radium salt upon the surface of some sterilised gelatin contained in a test-tube, and then to await development. That did not take long. Almost at once a faint cloudiness appeared to start under the speck of salt which extended downwards into the gelatin, in some cases after twenty-four hours reaching the depth of one centimetre. No heating was required to bring about this "growth," which resembled to the unaided eye an ordinary mould. The experiment was made with radium preparation of varying degrees of activity, but it was soon observed that the degree of activity in the salt had little influence on the growth, a salt of radium barium bromide containing 1/1000 of its weight of active salt being nearly as efficacious as one containing 1/100. (The more pure specimens which I possess were too precious to experiment with.)

As the specimens used were composed chiefly of barium salt, it occurred to me that it might be interesting to try the effect of the pure barium salts on the gelatin. This was done, with the surprising result that the "growths" were just as easily obtained as with the radium preparation—or even more so. I have tested all the barium salts at my disposal, and find the following produce the effect:—Barium, oxide, dioxide, chloride, bromide, iodide, nitrate, acetate, tartrate, and sulphovinate, while the phosphate, carbonate, sulphate, and borate do not act. Thus the soluble salts are active, and the insoluble ones inactive.

The method adopted for the experiments was as follows:—Some clear gelatin was poured on to a glass slip and allowed to set. A tiny speck of the salt was placed on the gelatin and covered with a thin glass. This slip was then placed on the stage of a microscope and examined with a ½-inch power. At once the "growth" was seen to shoot out from the speck, and it appeared to consist of bubbles, some large, but most of them very small. Half an hour afterwards the speck had dissolved, leaving in its place a nebulous patch many times the size of the speck. The action of barium iodide is particularly rapid, while that of the hydrate is rather slow. I have tried uranium and thorium salts, both of which affect the gelatin rapidly, but do not produce the "growths." The action of these salts upon gelatin seems to point out an interesting field of inquiry, which I propose to follow.

W. A. DOUGLAS RUDGE.

Woodbridge School, Suffolk.

The Problem of "Shadow-bands."

SUBSEQUENTLY to the Algiers eclipse of 1900, it occurred to me that the "shadow-bands" visible at times of total solar eclipse might be merely another aspect of the "boiling" distortions of the sun's limb inseparable from daily observations. The last few years have therefore been employed by me in studying the characteristics of "boiling" with the view of making a direct comparison of evidences at the first opportunity. This opportunity presented itself in the recent total solar eclipse observed by me at Cás Catalá, in Mallorca, on August 30 last.

Employing "Carrington's method" of projecting the sun's image with a small telescope, the first observation made at about 10 a.m. recorded the existence of two distinct layers of cloud, the lower one travelling N.E. by S.W., and the upper one W.S.W. by E.S.E., giving confused and erratic "boiling." Further observations revealed an increased prevalence of the N.E. cloud system, but the drift from W.S.W. was still in evidence. At 11.35, however, it transpired that the W.S.W. system alone prevailed, and all trace of the drift from N.E. had abated. Continuing the observation without any relaxation throughout the phase of partial eclipse until within a few minutes of totality, I was able to ascertain that the "boiling" movements along the advancing limb of the moon were throughout absolutely in agreement in every particular with the movements of distortion affecting the still uncovered limb of the sun. Observations by projection were abandoned at 1h. 18·0m. for the purpose of securing a naked-eye view of "shadow-bands." A very successful view of these was secured. Their direction of flight determined on the spot, and afterwards corrected by Dr. Hunter, of Edinburgh, by the compass, proved to be W.S.W. by E.S.E. It is noteworthy that at Palma, where the eclipse conditions were marred throughout by the cloud bank that had threatened to overwhelm us at Cás Catalá (only four miles S.W. of Palma), the "shadow-bands" were observed to take a direction N. 30° E. by S. 45° W.

CATHARINE O. STEVENS.

Bradfield, Berks, October 20.

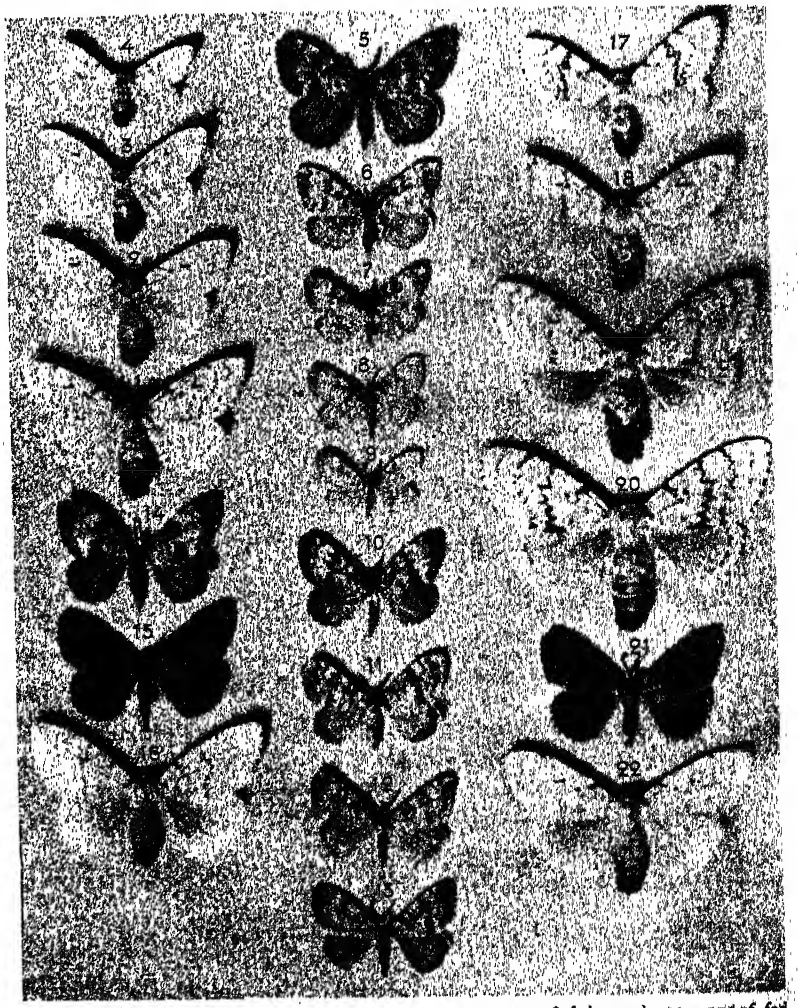
Rhymes on the Value of π.

Now I know a spell unfailing,
3 1 4 1 5 9
An artful charm, for tasks availing,
2 6 5 3 5 8
Intricate results entailing.—
9 7 9
Not in too exacting mood,
3 2 3 8 4
(Poetry is pretty good),
6 2 6 4
Try the talisman.—Let be
3 3 8 3 2
Adverse ingenuity!
7 9

EXPERIMENTS ON VARIATIONS OF LEPIDOPTERA BY ENVIRONMENT.

An important addition to the numerous papers of recent years recording experiments as to the influence upon the forms of living beings of their environment has lately been published.[1] In this paper the inquiry is concerned only or chiefly with varieties in the pigmentation of Lepidoptera. The author enumerates as among the agents to which change in this pigmentation is to be ascribed "intensity of light, temperature, nutrition, humidity, dryness, electricity, and other meteorological phenomena." His references to the literature on these subjects are very useful. The suggestion that mechanical movement, jarring, of pupæ, might cause effects analogous to those of temperature is mentioned, but this has long since been abandoned. M. Pictet divides the variation of pigmentation into two opposite types, the one "albinism," by which red can pass into yellow and even into white, the other "melanism," by which red passes into brown and, as an extreme, into black; and this classification is kept in view all through the description of his experiments and their results. So is a theory which he puts forward, though with diffidence, that caterpillars in general were originally adapted to live only on certain special plants or trees, and afterwards, owing to finding themselves, as the result of migration or otherwise, where these were not to be had, adapted themselves to many other kinds, so as to become more or less polyphagous, still, however, in nature attaching themselves by preference to special food plants, called in this paper their normal or ancestral ones.

M. Pictet's treatment of this subject can be best illustrated by an extract:—"*Lasiocampa quercus,* known from the time of Linnæus as feeding almost exclusively on the oak, as indeed its name indicates, and the leaves of some trees and hedge shrubs, is now found frequently on ivy, poplar, sallow, birch, heath and arbutus." He does not always say what the normal food plant is, as in the case of *Phalera bucephala,* of which he states that it absolutely refuses to eat any but its normal food. In England it is found on lime, elm, willow, and many other forest trees at least as freely as on oak, and there is a record of a company found on laurel. Oak is given as the normal food of *Biston hirtarius* (found in England on a great variety of forest trees), gooseberry and spindle tree (*Euonymus europaeus*) as those of *Abraxas grossulariata.* In England this species is found in abundance also on blackthorn, &c., and it has of late years addicted itself to the *Euonymus japonicus*, an evergreen which became widely distributed in Europe during the last century. Though, as stated, it is left uncertain in some cases what M. Pictet considers the normal food plants to be, that creates little or no difficulty in appreciating most of his experiments, as the kinds of food plants which in these experiments were substituted for the foods well known to be usual were so different that they may certainly be distinguished as abnormal; for example, when walnut or laurel, or low plants such as sainfoin (*Onobrychis sativa*), dandelion, lettuce, or salad burnet (*Poterium sanguisorba*) are substituted for any of the ordinary forest trees.



FIGS. 1 and 5.—*Ocneria dispar*, typical form ♀ and ♂; 2–4, 6–13, 17, 18, fed on walnut; 14 and 16, fed on mespilus; 15, fed on dandelion plants; 20 and 21, fed on onobrychis; 22, fed on poterium plants.

Among the principal conclusions arrived at by M. Pictet are the following:—(1) Change of ancestral food plant is often a factor of variability. (2) In general, a food difficult to absorb and digest prevents the larva from developing within its usual period, and this longer larval period is associated with the shortening of the pupal period, and consequently with insufficient pigmentation. (3) Normal food plant in insufficient quantity has the same effects. (4) A food easy to take in (ingérer) and rich in nutritious elements accelerates the larval development, and thus reacts on the duration of the pupal period, which, being thus lengthened, a more intense pigmentation

[1] "Influence de l'Alimentation et de l'Humidité sur la Variation des Papillons." By Arnold Pictet. (*Mémoires de la Société de Physique et d'Histoire naturelle de Genève*, vol. xxxv., fascicule 1, June, 1905, pp. 46–127.)

ensues. . . . (8) The variations produced by food increase in intensity with each generation, and even arrive at such a point as to persist to a degree, by heredity, in the next generation brought up on normal food; when, in successive generations, the food plant is different, each kind of food plant impresses its characteristic effects on the imago. (9) After some generations on the abnormal food the insect becomes accustomed to it, and this brings about a return to the primitive type—sometimes, indeed, passes beyond it in the opposite direction.

The experiments which led to these conclusions extended over five years, from 1900 to 1904, and were tried on 21 different species and about 4695 individuals. The paper is illustrated by five plates containing eighty-one photographic figures, which are excellent, but uncoloured, so that they have not the advantage of showing the distinctive colour effects which enter into the verbal description of the results obtained. The course of experiment can only be briefly indicated here, having due regard to the exigencies of space, but I may select for reference some of M. Pictet's chief experiments on what was their principal subject, *Ocneria dispar*; on this species there were twenty-nine experiments upon 1568 individuals. In many of those tried on this and other species the differences from the normal, so far as they are shown by the plates, are not very distinguishable from those deficiencies in intensity and definiteness of marking and the dwarfing of size that one is accustomed to find when larvæ are bred on food that is insufficient or unsuitable, to put it in a popular form, are "half starved." It is right, however, to say that M. Pictet considers, as afterwards mentioned, that in those examples which he has selected for illustration as exhibiting the effects of abnormal food plants, walnut, onobrychis, &c., they are distinguishable from each other to such an extent that where larvæ have been fed for three successive generations on walnut, onobrychis, and oak respectively, the special influences of all three food plants can be seen.

In six experiments with *O. dispar*, walnut was given for one or more generations; in all these cases the wing expansion was considerably smaller than normal, in some cases not more than three-quarters or two-thirds of it. Where *O. sativa*, dandelion or *P. sanguisorba* was given the imagines were considerably larger than normal, but when in one or more of the succeeding generations walnut was substituted the size was immediately reduced, much as in the other six experiments. *Mespilus germanicus*, horse chestnut, white poplar, and sallow had effects very similar to those of walnut. In experiment (4), where oak in the second generation succeeded walnut in the first, there was a slight return towards the type, but when in the third generation walnut was again given, the failure in intensity of markings reached its minimum, there being scarcely a trace of colour; when, however, in the fourth generation oak was again given, there was a nearer return towards the type than the second generation showed. In other cases the "albinistic" influence of the walnut persisted in a very marked degree after two later generations fed on oak or on *O. sativa*. In such cases, also, where other food plants of the three different classes ("albinising," "normal," and "melanising") had been given in succession, M. Pictet considers that the special pigmentation effects of each of the three kinds of food plant are shown by the imagines of the latest generation. These are for walnut, ♂, pale yellow colour, two central lines partly obliterated, other markings less intense; ♀, wings slightly transparent, few markings on upper wings, more on lower; second generation, ♂, wings whitish, marginal band on all partly obliterated, transverse lines little visible; ♀, wings transparent, the V mark and the marginal dots alone appearing; for *O. sativa*, ♂, wings brown, zigzag, lines little noticeable, marginal band very dark, abdominal hairs greyish; ♀, on upper wings white zigzag lines strongly marked; for *dandelion*, ♂, very similar, only the lower wings of uniform dark colour.

M. Pictet arrives at the general conclusion that the "albinising" variations are caused by the larvæ having been fed on leaves presenting obstacles to nutrition, such as hard cuticle or felted underside, as in white poplar, and that, on the other hand, the "melanising" variations are caused by food presenting no such obstacles; thus the young leaves of laurel are not "melanising" as the old leaves are. So far as I am aware, M. Pictet's conclusion that a difference of food plant in one generation can cause a difference of facies in the imago, and one that persists for several generations, is not in accordance with views hitherto prevailing; its bearing on the question whether a quality thus acquired can originate a new permanent variety or species is, however, at least materially affected by M. Pictet's other position, that where several generations have been brought up on the abnormal food so as to become accustomed to it, they revert towards the original form, so that there would appear to be only a temporary disturbance in the colouring of the species.

All M. Pictet's figures of *O. dispar* are reproduced as illustrative of this notice; those numbered 13 (walnut, oak, onobrychis), 14, and 16 (onobrychis, mespilus) are relied on by him as showing indications of each of the different food plants supplied to them and their ancestors, that numbered 10 (walnut, oak, walnut, walnut) as showing reversion towards the original normal form when the larvæ have for several generations been confined to abnormal food.

With respect to M. Pictet's position that an inverse rate of development in the pupa is caused by lengthening or shortening the duration of the larval "diapause" or period of repose, his experiments favour that view; but it will hardly be accepted as of general application without further experiments.

There is a section on the influence of food on the colour of the larvæ in which M. Pictet states that such an influence is exerted, with observations tending to show that in some cases there is a relation between the colour thus induced in the larva and the colouring of the imago. There are also experiments from which he draws the conclusion that the kind of food influences the secondary sexual characters of the larvæ which are so marked in *O. antiqua*, &c.; this does not, of course, mean that it changes the sex as has been asserted; on that he makes the just observation that it is not sufficient to count the respective numbers of males and females among the perfect insects obtained, but account ought also to be taken of those that die, usually in large numbers, and the male sex may be much more capable than the female of supporting the "tribulations of life," among which, one may add, must certainly be included scientific experiments on their food.

The second part of M. Pictet's paper is devoted to the influence of humidity. Excessive moisture applied to young larvæ is largely fatal, but seems to have no effect on the perfect insects which survive, beyond slightly reducing their size. Older larvæ, *i.e.* (usually) for the period of eight or ten days before pupation, resist it perfectly, but give "aberrations," some of which are figured, such as are met with here and there in nature.

The paper is a valuable contribution of facts to the solution of questions of much interest, and M. Pictet's conclusions as to the causes of the results he describes are well worthy of the consideration that they will doubtless receive. It is to be presumed that he took all proper means to isolate the influences he applied from other influences, but his arguments would perhaps have gained in force if he had stated in detail what steps he had taken to ensure this isolation. For example, in his experiments on the colouring assumed by larvæ, though he is acquainted with the experiments of Prof. Poulton and others, showing the undoubted effect of a few coloured surroundings on the colouring of the larvæ of many species, it does not appear what precautions were taken to exclude the operation of such surroundings; nor in the experiments on the duration of the pupal stage when the larval "diapause" was shortened, or in the humidity experiments, does it appear that the temperatures during all the time of the pupal stage were noted; it is known that a very moderate difference in temperature will make a difference of many days in the duration of this period. One may venture to suggest, also, that in the continuation which it is hoped M. Pictet will make of his valuable experiments he will give as far as possible the whole number of the insects in the broods at their commencements and the whole number of perfect insects reared —in the great majority of cases only percentages are given; also that he will state whether the whole or nearly the whole of those reared were similar in appearance to those figured, and whether there was any considerable proportion substantially different.

There appears to be one error to which, as it has not the character of a mere slip, and therefore has a bearing on the arguments used, it is necessary to direct attention. The larvæ of the first generation of the year of *V. urticae* are at p. 94 mentioned as coming from butterflies which "have probably passed the winter in the chrysalis stage," and at p. 81 "certain Vanessas" are spoken of as being able to pass the winter in the egg, chrysalis, or winter stage. Surely *V. urticae* hibernates only as an imago, wherever there is a real winter, as is the habit of the Vanessas generally. Again, fifteen to twenty days is stated as the usual period of the larval life of *Argynnis paphia*; in England this hibernates as a very young larva, and feeds up, very quickly it is true, during April, May, and June, appearing as an imago in July or early August, and this is its usual habit on the continent of Europe.

F. MERRIFIELD.

CHEMISTRY IN THE SERVICE OF THE STATE.[1]

IN the year 1840, the Legislature made an interesting fiscal experiment. It repealed all previous enactments against the adulteration of tobacco, and permitted any ingredients, "except the leaves of trees, herbs, and plants," to be added to that article in the course of its preparation. The result was that tobacco speedily became grossly adulterated; in two years the consumption had decreased by more than a million pounds; and, since tobacco is a heavily taxed commodity, the Exchequer suffered severely. So serious a loss had to be promptly stopped; hence in 1842 the prohibition of adulteration was re-enacted. To help in making the prohibition effective, the Commissioners of Inland Revenue fitted up a small laboratory, the staff of which, consisting for some time of one person only, was occupied solely in detecting fraudulent additions to tobacco.

Such was the modest origin of the chief branch of the institution which now undertakes nearly all the analytical and consultative chemical work required by the various Government departments. Another branch, the Customs Laboratory, may be said to owe its inception chiefly to the Sale of Food and Drugs Act, 1875, which laid upon the Board of Customs the duty of supervising the quality of imported tea. The two branches were affiliated in 1894 under one head.

How considerable the business of the laboratory has now become may be gathered from the recently issued report of the principal chemist, describing the work of the department during the last financial year. From this it appears that the number of samples analysed in that period was no less than 138,508. Of these, 49,751 were examined in the Customs branch, and the remainder, 88,757, in the main laboratory at Clement's Inn Passage.

What, however, more particularly strikes one is the wide range of interests, both of the State and of the individual, which are touched at one point or another by the chemical activities of the department. We extract from the report a few notes which may serve to illustrate this, and to indicate the nature of the questions dealt with.

Dealing first with the Customs, the ultimate aim of the various analyses is, of course, to facilitate the just assessments of Customs dues. This, however, involves the testing of many articles which are not themselves dutiable. For instance, genuine cider is free of duty. A temptation is thus offered to an unscrupulous wine importer, since by labelling his wine as "cider" he may, if undetected, get it passed into the country without payment. As a matter of fact, out of 154 samples examined during the past year, 10 represented importations of so-called "cider" which was found to be chargeable as wine, and another had to pay duty as a spirit preparation. Again, crude methyl alcohol is admitted free, but if purified so as to be potable must pay the spirit duty. In 31 cases out of 256 the substance was, in fact, so pure that the full alcohol rate was levied.

As compared with the previous year, there has been a notable decrease in the number of certain beer, wine, and liqueur samples; this is attributed to diminished consumption of alcoholic beverages. On the other hand, samples of tea show a considerable increase—from 2345 to 3260—in spite of an augmented tea-duty. For various reasons, 316 of these specimens of tea were objected to, and 7 were condemned as unfit for human food.

Among other items of interest, we note that facilities are given by the Customs authorities for the utilising of waste tobacco in the preparation of sheep dips and similar articles. It appears that nicotine is supplanting arsenic as the active principle in such products.

The very high duty on saccharin—20s. per pound—involves, the principal chemist remarks, a careful outlook for this substance in the most unlikely places. 617 samples of articles which might have been vehicles for its fraudulent introduction were tested, and 55 of the number were charged the duty as being either saccharin or substances of like nature and use.

In the laboratory at Clement's Inn Passage, the business is classed as (1) Revenue work; (2) work for other Government departments; and (3) the analysis of samples referred by magistrates to the Government chemists in disputed cases under the Sale of Food and Drugs Acts. The examinations of excisable articles are devised to secure the revenue accruing from beer,

[1] "Report of the Principal Chemist upon the Work of the Government Laboratory for the Year ending March 31, 1905." Official Publication, Cd. 2591. Price 3*d*.

spirits, and tobacco. For instance, beer-duty is charged according to the specific gravity of the brewer's wort before fermentation, and this gravity is "declared" by the brewer himself. To test the accuracy of such declarations, 6370 samples of wort in various stages of fermentation were analysed, with the result that the amount of duty was increased in more than 10 per cent. of the cases. Again, on beer which is exported, "drawback" corresponding to the original duty can be claimed: to check the claims, samples of the beer are analysed; and during the year 2789 barrels were found to be not entitled to the drawback claimed. 813 samples of beer out of 6589 taken from publicans were shown by analysis to have been illegally diluted with water. Of so-called "temperance" drinks, about one-third of the whole number examined, 1011, contained alcohol in excess of the legal limit, the highest quantity being about as much as in ordinary light beer. Forty-four specimens of beer and brewing materials were found to contain arsenic in objectionable amount.

As regards spirits, it is noted that the exportation of medicinal tinctures, flavouring essences, and perfumes is increasing. So, too, is the use of denatured alcohol for industrial purposes, and of pure duty-free spirit issued to medical and other science schools.

Tobacco is examined chiefly to prevent an excessive admixture of water or oil; penalties were imposed in 87 cases of this kind during the past year, and also in other instances where glycerin and liquorice were unlawfully present.

Legal proceedings are necessarily a feature of the chemical control over dutiable articles. Penalties aggregating 5072*l.* were imposed during the year in respect of offences proof of which depended upon the analytical evidence.

Much work, of very varied scope, is carried out for the Admiralty, the Boards of Trade and Agriculture, India Office, Post Office, War Office, and other State departments. Imported dairy produce, for instance, is analysed for the Board of Agriculture in order to check the importation of adulterated foodstuffs; 2468 such articles were examined in the year, of which 2110 were butter and 305 milk and cream. Boron preservatives and artificial colouring-matter are found to be common additions to the butter. The use of the preservative is increasing; but, as the principal chemist points out, there is a difficulty in restricting the admixture so long as a legal limit has not been fixed. In two other respects it would seem that the law might well be amended. Butter, about the purity of which there were grave doubts, and cheese containing merely nominal amounts of fat, had, "in the absence of legal limits," to be admitted into the country without objection; this seems hardly fair, either to the home farmer or to the consumer.

In connection with the testing of filters, a useful note of warning is given to the makers of these articles. The actual filtering material may be quite satisfactory, but as regards giving a sterile filtrate the whole apparatus is sometimes rendered useless by leakage of unfiltered water through faulty fittings.

For the Home Office an interesting series of lead-glaze samples was examined during the year. It may be remembered that cases of lead poisoning in the pottery industry had a few years ago become so numerous as almost to constitute a public scandal. Profs. Thorpe and Oliver, who were commissioned by the Home Secretary to investigate the matter, recommended, among other remedial measures, the substitution of lead silicates for the white lead then in general use as a glazing substance, on the ground that the silicate, properly compounded, would be almost insoluble in the acids of the gastric juice, and therefore far less poisonous than the easily soluble white lead. Based on this recommendation, a regulation was framed by the Home Office; it was, however, thought by the potters to be too stringent, and eventually the point was submitted to arbitration, Lord James of Hereford being umpire. His award was in the nature of a compromise giving the manufacturers greater freedom than under the original proposal. The conditions are set forth in the report, together with the results of the analyses of samples of glaze showing how nearly the manufacturers, in the first year's working of the new rules, have been able to keep their glazes within the specified limits. On the whole, the results are fairly satisfactory. Thus thirty samples were represented as "leadless," and all but four did, in fact, conform to the regulation.

The India Office requires the analysis of a great variety of articles, which are examined in order to ensure that goods supplied by contractors are actually what they purport to be. Metals and alloys, cements, chemicals, disinfectants, drugs, food preparations, oils, paints, and surgical dressings were among the supplies sent for analysis during the year; but how far they proved to be satisfactory is not stated.

In cases which arise under the Sale of Food and Drugs Acts there may be a conflict of testimony, and the magistrate may wish to have before him independent evidence upon the chemical aspects of the question. In such matters the Government Laboratory acts as *amicus curiae,* and examines a sample of the article in dispute which has been specially reserved for that purpose. Further, whether the magistrate wants it or not, either of the litigants can claim to have this reserved sample forwarded for analysis. This is an excellent provision, securing as it does a careful examination of the disputed points by chemists unconnected with either prosecution or defence, and detached from any local influences which might, however wrongly, have been alleged or suspected by an accused person to have been used against him. During the past year this provision has been taken advantage of in 109 instances. The net result of the references was to support the allegation brought against the article in the great majority of cases, viz. in 95 out of 105.

The report bristles with matters of interest similar to the foregoing. It is the record of a useful year's work.

ON THE ORIGIN OF EOLITHS.

The more detailed paper by M. Marcellin Boule on the subject of the origin of eoliths (see Nature, August 31, p. 438) has now appeared in *l'Anthropologie* (Tome xvi., p. 257), and was briefly noticed in Nature of September 28 (p. 538). The paper is too long for us, with the existing pressure upon our space, to give a full translation of it, but the following are the principal new features in the extended essay. The velocity of the circumference of the wheels in the *délayeurs,* or vats, is stated to be about 13 feet per second, the same as the speed of the Rhone in times of flood. It will therefore be seen that these mixing vats are of an entirely different character from ordinary pug-mills, and that the motion of the water in them may be properly described as torrential. The author attaches no importance to the fact that some of the blows to the flints are given by the iron teeth of the suspended harrows, and states that most of the flints are reduced to the condition of rolled pebbles, identical with those to be found in all flint gravels, but that there are numerous examples of *rétouches,* or secondary working. In illustration of this he gives photographic figures of eleven different specimens by which he contends that

the analogy of these flints from the cement manufactory near Mantes with the so-called eoliths from Tertiary beds is substantiated, and he regards it as undeniable that these Mantes eoliths have been produced, and are being continually produced, apart from the intention of any human being.

In conclusion, he directs attention to the importance of migration both in history and in the development of all fossil groups. Nothing, he says, proves that the evolution of the human species or genus took place in one particular spot. It is very possible that man appeared suddenly in this part of the world at the beginning of the Quaternary period, at the same time as the mammalian fauna of which he forms part, and which is very different from the last fauna of Pliocene times. As a palæontologist, he believes firmly in the existence of Tertiary man, traces of whom, he doubts not, will eventually be found in some part of the world; but for these to be indisputable, they must possess a very different value from that of the eoliths.

In addition to M. Boule's memoir, an important article has appeared in the *Archiv für Anthropologie* (Neue Folge, vol. iv., p. 75), "Zur Eolithenfrage." It is from the pen of Dr. Hugo Obermaier, of Paris, who has also visited the cement works near Mantes, and entertains views upon the subject almost identical with those of M. Boule. He begins with a historical sketch of the discoveries of eoliths in beds from the Oligocene downwards to the Quaternary, and then proceeds to describe and discuss the modern products of the *délayeurs*, of one of which he gives a section. The paper is illustrated by eight plates, six of which are photographic. The first gives eight specimens of reputed eoliths from Miocene beds at Duan, near Brou (Eure et Loire). The other five are devoted to examples from Mantes, not a few of which present the "hollow-scraper" notches so often seen on eoliths. The remaining two plates contain reproductions of wood-cut figures of eoliths from various localities, so as to afford means of comparison between the old and the new.

He directs attention to an admission of M. Rutot that the eolithic industry is confined to localities where two conditions exist, the one that there was an abundance of the raw material flint, and the other that there was a stream of water in the neighbourhood, conditions which, in a modified form, exist at Mantes.

Want of space precludes a longer notice of this interesting article. We may, however, quote Dr. Obermaier's words in a letter to the editor of the *Archiv für Anthropologie* (Neue Folge Corr. Blatt., July, 1905, p. 50):—"We have now an experimental proof that eoliths can be formed in a purely mechanical manner."

NOTES.

As already announced, the inaugural meeting of the British Science Guild will be held on Monday next, October 30, at the Mansion House, at 4.15 p.m. The Lord Mayor will preside, and will be supported, among others, by the Lord Bishop of Ripon, Lord Strathcona and Mount Royal, the Right Hon. R. B. Haldane, K.C., M.P., Admiral Sir Cyprian Bridge, G.C.B., General Sir Frederick Maurice, K.C.B., Sir John Wolfe-Barry, K.C.B., F.R.S., Sir William Ramsay, K.C.B., F.R.S., Mr. C. W. Macara, and Sir Norman Lockyer, K.C.B., F.R.S.

A MEETING of the general committee of the British Association will be held in the rooms of the Linnean Society, Burlington House, on Tuesday next, October 31, at 3 p.m., for the purpose of appointing officers for the meeting of the association to be held at York next year, and of deciding upon the place of meeting in 1907.

THE Paris correspondent of the *Times* states that M. Gérault-Richard proposes to ask the French Parliament to vote a credit of 100,000 francs (4000*l.*) for the investigation of the best means of combating tuberculosis. The Minister of Education, M. Bienvenu-Martin, has promised the support of the Government.

THE death is announced of Prof. DeWitt Bristol Brace, head of the department of physics in the University of Nebraska, and one of the leading physicists of the United States. He was in his forty-seventh year, and had just entered upon his nineteenth year of teaching in the University of Nebraska.

AN international exhibition in connection with ceramic industries, and with the manufacture of glass and crystal, will be held in 1906 from June to October at the Champs-Elysées and the Cours-la-Reine. Full information can be obtained from the director-general of the exhibition, 19 rue Saint-Roch, Paris.

WE learn from the *Pharmaceutical Journal* that the Heriot trust governors have decided to establish a laboratory at the Heriot Watt College, Edinburgh, for the study of bacteriology in its relation to various industries. The laboratory has been fitted with the best appliances, and the services of Dr. Westergaard have been retained to supervise it. The laboratory was formally opened by a lecture by Prof. Hansen on October 18.

A STRONG earthquake shock was felt in Constantinople on October 22 at 5.55 a.m. The disturbances, which lasted several seconds, appeared to travel from the north-east towards the south-west, and were accompanied by a rumbling noise. Earthquake shocks were felt at 2 p.m. on the same day at Batum, and between 2 p.m. and 5 p.m. at Kutais. An undulating tremor lasting forty seconds was also experienced at Sukhum-Kaleh.

A CONFERENCE of delegates from the corresponding societies affiliated to the British Association will be held in the rooms of the Linnean Society on Monday and Tuesday, October 30 and 31, under the presidency of Dr. A. Smith Woodward, F.R.S. Among the subjects to be discussed are "The Preservation of Native Plants," to be introduced by Prof. G. S. Boulger, and "The Law of Treasure Trove," which will be introduced by Dr. W. Martin. The delegates will visit the museum of the Royal College of Surgeons, and will dine on Monday evening as guests of the Royal Societies Club.

A REUTER message states that the Berlin Meteorological Observatory, which the Emperor recently opened in the presence of the Prince of Monaco, is fitted with all the latest appliances for meteorological research. The Emperor attaches great importance to the use of balloons in meteorology, so that an extensive balloon hall has been included in the building plan of the new observatory at Lindenberg, near Berlin. On the highest point of the plateau on which the observatory stands is a shed which can be turned to any point of the compass, and contains a cable drum driven by a small electric motor for hauling in kites, which are to be extensively used for meteorological purposes. Electric search-lights have also been installed for night observation. Another interesting feature of the new institute is the kite factory, where large kites, fitted with self-registering instruments, are made. The institute has its own establishment

where balloons can be filled, and it is the present intention of the directors to make observations with balloons every first Thursday in the month.

DR. BÁTHORI ENDRE, writing from Királyfalva, Hungary, informs us that the Bólyai international prize will be presented next December, for the first time, by the Hungarian Academy of Sciences. The prize is ten thousand crowns, and will be awarded every five years, in memory of John Bólyai, the celebrated Hungarian mathematician, to the writer of the best mathematical work in the same period of years. The committee concerned with the award of the prize met on October 11 in Budapest. The members of the committee are:—Prof. G. Darboux, Paris; Prof. F. Klein, Göttingen; Prof. G. König, Budapest; and Prof. G. Rados, Budapest. The names of two mathematicians were considered, viz. Prof. H. Poincaré and Prof. D. Hilbert. The committee awarded the prize to Poincaré, and at the same time expressed its acknowledgment and admiration of Prof. Hilbert's works. Profs. Darboux and Klein gave lectures in Budapest on the teaching of mathematics.

THE inaugural address of the Manchester Literary and Philosophical Society was delivered, on October 17, by Sir William H. Bailey, the president of the society. The address took the form of an interesting historical account of the society since its foundation in 1781, and included appreciative references to the work of many distinguished members whose names are to be found in early volumes of memoirs. The founders were the chief scientific men of Manchester. Among the honorary members were Erasmus Darwin, Dr. Franklin, Lavoisier, Dr. Priestley, William Roscoe, of Liverpool, the poet and grandfather of Sir Henry Roscoe, Dorning Ramsbottom, Josiah Wedgwood, and others. The chief tools of the workshops of the world, not only those where steam engines, locomotives, and steamships are built, but also of the textile factories of the world, were invented in Manchester or within thirty miles of it. The records of the society contain the names of many of these inventors who were members, for the men of Lancashire were the first to use steam power for spinning and weaving, and for punching, cutting, and shaping metal. Prominent among the inventors was that genius Richard Roberts, who was always in the front rank in advocating technical education. His chief inventions were the slide lathe, planing machine, and self-acting mule for spinning cotton. Then there was Nasmyth, the inventor of the steam-hammer, Sir William Fairbairn and Sir Joseph Whitworth. Finally, Sir William Bailey referred to the great work of the illustrious members Dr. Dalton and Dr. Joule, whose effigies in marble are in the entrance to the Manchester Town Hall.

PLANS have been formulated by Mr. Einar Mikkelsen, a young Dane, for an expedition to the Arctic regions, the objective being that part of the Polar Ocean which lies immediately to the west of the Parry Archipelago, north of Canada. Interviewed by a representative of the *Morning Post*, Mr. Mikkelsen gave an outline of his programme. He will be joined by Mr. Leffingwell, a young American geologist, and Mr. Ditlevsen, a naturalist, who, like Mr. Mikkelsen, accompanied Lieut. Amdrup to the east Greenland coast in 1900. It is proposed to start from Canada in the spring of 1906. Early in May the party hopes to reach the upper waters of the Athabasca River, by way of Edmonton, and to follow that stream, and the Slave and Mackenzie Rivers, down to the northern coast of the Dominion. It will be some time in July before the mouth of the Mackenzie River is reached. At the end of August a whaler, which will have been brought north especially for the use of the expedition, will be joined by the party. Geological and zoological investigations and study of the native Eskimo will occupy the time of waiting. At Cape Kellet it is hoped that winter quarters will be established. The winter is to be occupied with scientific investigations. The plan is that about the end of February the party, three white men, two Eskimo, and the dogs, shall start out from Prince Albert Cape in a N.N.W. direction, that is, more or less parallel to the mainland. Ten days, it is calculated, should see an end of the bad ice, and then Mr. Ditlevsen is to return, leaving Messrs. Mikkelsen and Leffingwell to continue the journey alone. They hope to keep on in the same direction as far as latitude 76° N., in about 147° west longitude, before turning south to reach the coast.

THE Tottenham Urban District Council has issued a public appeal for subscriptions for the purpose of furnishing a museum and for the donation of objects of interest. An opportunity occurred during the present year for securing a collection of minerals and other geological specimens for a nominal sum, and at the same time an offer was received from Mr. H. E. H. Smedley to lend his museum collection to Tottenham and to give his services as honorary curator. The council has accepted the offers. The cost of furnishing the museum is estimated at 250*l*. Any contributions in money, or suitable objects for exhibition, may be sent to the librarian at the Central Public Library, High Road, Tottenham.

THE increased sale of synthetic indigo promises, a writer in the *Journal of the Society of Arts* states, to destroy the old and important Anglo-Indian industry of indigo planting. Since 1895–6 the value of the exports has fallen from 3,569,700*l*. to 556,400*l*., and this is largely due to synthetic indigo. Of the indigo imports of Japan last year fully three-fourths was the artificial product, vegetable indigo being increasingly unsalable. In the United States the synthetic dye came on the market in 1898, and was held at 44 cents per pound, about the value of vegetable indigo on the indigotin basis. Now the price is down to 18 cents, and at this figure it is claimed to be much cheaper than the lowest obtainable values in any vegetable indigo. The artificial dye has already secured nearly 85 per cent. of the world's consumption, and the price of indigo has dropped about one-half. To-day Germany imports only small quantities of natural indigo, while her exports of synthetic indigo have increased enormously, and represented last year a value of 25,000,000 marks.

THE study of the zoology of the Philippines is being energetically carried on by the Americans, one of the latest contributions being the description of new Hymenoptera, by Mr. W. H. Ashmead, published in the *Proceedings of the U.S. Nat. Museum* (No. 1416).

THE Agricultural Society of Sapporo, Japan, is devoting its energies to the study of the insects of the country and the mischief they inflict on agriculture, forestry, &c. In the first and second parts of the second volume (the first volume being at present apparently unpublished) of the society's journal, of which we have been favoured with copies, all the papers except one are, for instance, devoted to insects and their life-history. The groups discussed include the Cercopidæ, or lantern-flies, the freshwater Hemiptera, and the bark-boring beetles of the family Scolytidæ. In the article referred to above, Mr. S. Hashimoto takes into consideration the composition of certain abnormal samples of milk.

THE papers in the *Zeitschrift für wissenschaftliche Zoologie* (vol. lxxx., part i.) include one by Mr. V. Widakowich on the structure and function of the so-called nidamental organs (that is to say, the glands which secrete the white and shell of the eggs) of the shark *Scyllium canicula*. In a second Mr. A. Reichensperger describes the anatomy of the living West Indian crinoid *Pentacrinus decorus*. A third, by Mr. O. C. Glaser, is devoted to certain features in the physiology of the American gastropod *Fasciolaria tulipa*, while in a fourth Messrs. Marshall and Dernehl commence a dissertation on the embryology and anatomy of the hymenopterous insect *Polistes pallipes*.

To the first part of the eightieth volume of the *Zeitschrift für wissenschaftliche Zoologie* Dr. O. Grosser communicates an interesting paper on the evidence that certain dermal structures or markings among vertebrates have a segmental origin. Among the features referred to are the transverse arrangement of the scaling on the under surface and sides of the body in lizards, and the transverse colour-bands on the bodies of the banded mongoose (*Crossarchus fasciatus*), the tiger, and the zebras. In regard to the scaling of reptiles, the author admits that the transverse arrangement is very probably a secondary feature due to adaptation to the movements of the body, while he adds that the evidence for the segmental origin of the transverse stripes in mammals is purely of a negative nature, and requires something much more definite in its favour before it can be accepted. It may be added that if this segmental origin of colour stripes be accepted, it at once cuts away the ground from those who regard it as a special protective adaptation.

WE have received the first part of a work, to be completed in six parts, price sixpence each, entitled "I go a-walking through the Country Lanes." No author's name appears on the title-page, but the text is stated to be compiled from the Rev. C. Johns's "British Birds and their Haunts." Each part is to contain reproductions from photographs taken by Mr. Reid, of Wishaw, the incomparable excellence of which needs no commendation on our part. The aim of the book is "to outline a walk in the country, and to describe and picture the habits of the birds and the animals that are to be seen." The photographs in some instances might have been made to convey more information. On p. 13 we have, for instance, a charming picture of a flock of sheep coming out of a field, to which the legend "changing pastures" is subscribed. It would surely have been just as easy to mention that these sheep, as shown by their white faces and long wool, are Leicesters, or some nearly kindred breed.

THE Selborne Society has issued an illustrated circular in which attention is directed to the objects coming within the purview of that body, and the privileges enjoyed by members. "Birds in the Field and Garden" is the title of an article in the October issue of *Nature Notes*, the official organ of the society, in which the nameless author, while admitting that a certain amount of damage is inflicted on fruit and other produce, maintains that, on the whole, the visits of birds are advantageous alike to the gardener, the fruit-grower, and the farmer. In connection with this subject, it may be mentioned that we are acquainted with certain gardens where, owing to the damage done to the buds by bullfinches and other members of the finch tribe, the whole of the gooseberry and currant bushes have been enclosed in wire netting with a mesh small enough to prevent the entrance of birds. The experiment has been carried on for two seasons with the most satisfactory results, and there has been no necessity to take any special steps to free the bushes from insects. Here, then, is a problem for those who urge that birds are essential to the gardener.

IN *Biologisches Centralblatt* for October 1 Mr. W. M. Wheeler, of the American Museum of Natural History, and Father E. Wasmann discuss the discovery of "temporary social parasitism" among ants, and the inductions to be drawn therefrom as to the origin of "slavery" among certain members of the group. Mr. Wheeler claims to have been the first to describe this temporary parasitism in a *Bulletin of the U.S. National Museum* issued in October, 1904; but the corollaries from this discovery and inferences in regard to the general origin of slavery among ants were not published by him until the middle of February of this year. In conclusion, the writer urges that none of the observations published by Father Wasmann during all the years he has been engaged in the study of ants "are sufficient to accredit him with the independent discovery of temporary social parasitism as a general and regular phenomenon among certain Formicidæ." In a reply to this article, Father Wasmann very candidly admits that Mr. Wheeler is fully entitled to the credit of this discovery, although he apparently does not accept certain other claims made by the American naturalist

"CAN fish hear?" is a question discussed by Dr. O. Körner in a special issue of the *Beiträge zur Ohrenheilkunde*, published to commemorate the seventieth birthday of Prof. A. Lucae. The question is provisionally answered in the negative, and for the following reasons. It seems that many fishes are able to perceive rapid, consecutive vibrations communicated to water, but that such vibrations are taken cognisance of by means of the so-called auditory organs is highly improbable. This is supported by the fact that single loud explosions in water were totally disregarded by fishes belonging to no less than five and twenty distinct species of fishes. Moreover, the circumstance that the presence of the senses of sight and touch is easily demonstrable in fishes renders it probable that the same would be the case with hearing if it existed. Finally, the fact that fishes, and apparently also such isolated forms in other groups as are deaf, alone among vertebrates possess no organs comparable to the Cortischian nerve-terminations renders it probable that these organs are alone capable of transmitting auditory vibrations, the hypothesis that such vibrations may be received by the vestibular apparatus not being at present substantiated.

WE have received part ii. of an illustrated catalogue of the ethnographical collection of the Sarawak Museum (Journal No. 43, April, Straits Branch, Royal Asiatic Society), by Mr. R. Shelford. This section deals only with the objects worn for decorative purposes by the natives of Borneo. The question of the relationship between magic and personal ornamentation has not been lost sight of, but many inquiries have elicited little information of importance. Kalabit youths when visiting new districts wear a necklace of decorative seeds as a charm against evil spirits, and Land-Dyak men wear a necklet of beads and canines of leopard and bear for a similar purpose; the beads are frequently regarded as charms against specific diseases. The leglets of finely plaited fibre so commonly worn were at one time employed as currency; the Kayans say they feel quite naked if they do not wear these leglets. The catalogue is very well done, and is illustrated by adequate plates. If the whole museum is treated in this way the catalogue will prove to be a very valuable record of the ethnography of Sarawak.

THE *Bulletin du Jardin impérial botanique de St. Petersbourg*, vol. v., part iii., contains a description of new lichens from Central Russia and Siberia, by Mr. A. Elenkin, and an account of the vegetation on the chalk cliffs in the basin of the river Choper, by Mr. W. Dubjansky.

IN his report for 1904–5, the curator of the botanic station in Dominica states that spineless lime plants are in great demand, but that he is unable to furnish an adequate supply, as the fruits contain very few seeds; also, owing to the labour involved, the supply of budded orange stock is limited. Other plants in request are cacao, rubber—both Castilloa and Funtumia—and ordinary limes. Judging from the manurial experiments with cacao, extending over three years, the application of phosphate and potash with dried blood may be expected to give substantial increases in yield, while mulching with grass has produced even better results.

THE Department of Agriculture for British East Africa has issued a leaflet on the cultivation and commercial products of the cocoanut. The industry is one that requires some capital, as the plants only come into bearing in the sixth year, and meantime the cultivator is dependent upon the maize, ground-nuts, or any other crop that he may grow between the trees. The most lucrative product in East Africa is *tembo*, a liquor obtained from the cut end of the very young flowering spike. The Department of Forestry in the same colony has also inaugurated a series of leaflets, the first of which deals with timber trees, including a juniper, a Podocarpus, *Pygeum africanum*, and *Allophylus abyssinicus*.

WE have received a pamphlet entitled "The Growth of Oak in High Forest," by Prof. W. R. Fisher, president of the Royal English Arboricultural Society, in which the author points out the desirability of having a model oak high forest as an adjunct to the forestry school at Oxford. In spite of the fact that oak forests and oak timber have played such an important part in the history of England, we have not at the present day a typical example of oak high wood, that is, an area where all stages from the seedling to the mature tree are represented. In the above pamphlet Prof. Fisher proposes to have a working section of the oak wood in Windsor Park set aside for this purpose. The area required, 1200 acres, could surely be spared for this important purpose, and the author clearly shows how the present crop could with time be replaced by a series of age classes representing all stages in the growth of the tree and the forest from the beginning to the end of the rotation. The financial returns would be vastly increased thereby, more than counterbalancing and justifying any small initial sacrifice. The scheme deserves every encouragement, and we trust will be looked upon with favour by those in authority.

ONE of the best concise accounts of the Liége International Exhibition yet published is contributed by Mr. L. Ramakers to the October issue of the *Engineering Magazine*. Some excellent illustrations are given of the mechanical, mining, and metallurgical features. Several large engines for operation with blast-furnace waste gas were shown, notably a 1200 horse-power four-cycle double-acting horizontal tandem engine for the direct driving of a rolling mill at the Cockerill works. Another gas engine shown by the same firm is a 500 horse-power four-cycle double-acting twin cylinder for operation with coke-oven waste gas. A gas-producer of novel type was exhibited by the Deutz Gas Engine Works, the fuel for which consists of brown-coal briquettes. The same firm showed an eight horse-power locomotive with a benzene motor.

FROM the Rationalist Press Association there come cheap reprints of "The Fundamental Principles of the Positive Philosophy" and of Haeckel's "The Wonders of Life." The former book contains a translation of the two introductory chapters of Comte's "Philosophie Positive," that is, the account of Comte's main theses, of the law of the three states of knowledge and the nature of positive philosophy, together with the fulminations against introspective psychology which are now completely out of date. Haeckel's work is a supplement to the "Riddle of the Universe," and discusses life, death, morality, and many other things.

OUR ASTRONOMICAL COLUMN.

THE RECENT LARGE SUN-SPOT.—The accompanying reproduction shows the form and extent of the large sun-spot group referred to in these columns last week. This photograph was taken at 12 o'clock noon on Thursday last, October 19, when the group was plainly visible to the naked eye. A rough measurement shows that the group was then more than 100,000 miles long and about 55,000 miles across its greatest breadth. The smaller spot, seen in the N.W. quadrant, was of particular beauty, showing a very dark circular umbra surrounded by a symmetrical penumbra.

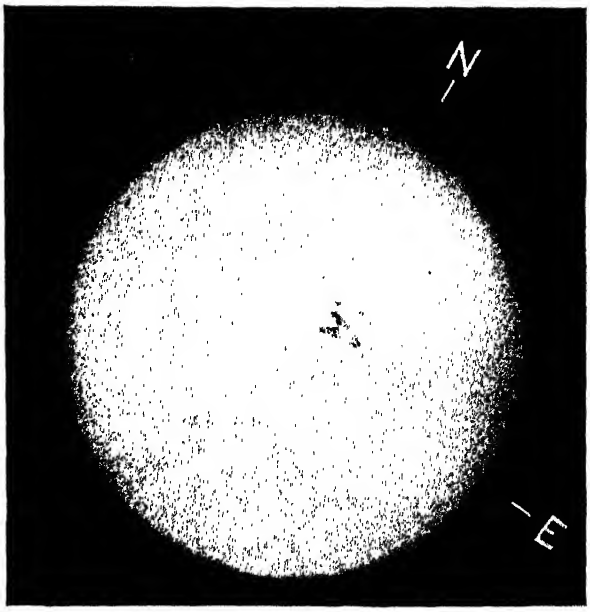


FIG. 1.—Photograph of the Sun showing the large group of sun-spots October 19, 12 o'clock noon.

A second "naked-eye" spot having a large black nucleus was seen near to the eastern limb of the sun on Monday last. This is the second occasion during the present year that the sun has presented the unusual phenomenon of two naked-eye spots visible on the disc at the same time.

FURTHER RESULTS OF THE FRENCH ECLIPSE EXPEDITIONS.—Yet another batch of the preliminary results obtained by French expeditions during the recent total eclipse of the sun is published in No. 15 of the *Comptes rendus*.

Prof. Janssen, who was in charge of the expedition stationed at Alcosebre (Spain), describes the observations which were made and the instruments which were employed at that station, and separate reports are pre-

sented by M.M. M. Stefanik, G. Millochau, and J. J. Landerer, who were in charge of the several instruments.

The results, which are of only a preliminary nature, are too numerous to give in detail here, but all the observations, both visual and photographic, appear to have been successful.

M. E. Stephan, of the Marseilles Observatory, was placed in charge of one of the expeditions organised by the Bureau des Longitudes, and, accompanied by M. Borrelly, occupied the same station as Mr. Newall, at Guelma (Algeria).

The equipment of this expedition consisted of a telescope of 40 cm. aperture and an equatorial of 9·5 cm. aperture and 190 cm. focal length. A number of visual observations of the corona, the prominences, &c., were successfully made.

NOVA AQUILÆ No. 2.—Circular No. 106 of the Harvard College Observatory describes the discovery and subsequent observations of Nova Aquilæ No. 2. The Nova was discovered on a plate taken with the 11-inch Draper telescope on August 18 for the Henry Draper memorial series. The spectrum, although faint, showed the lines $H\delta$, $H\gamma$, 4272, 4646, and $H\beta$ very broad and bright, $H\gamma$ and $H\beta$ having accompanying dark lines on their more refrangible edges. The helium line 4640 is slightly stronger than 4272, and the whole spectrum closely resembles that of Nova Persei No. 2, as photographed on March 30, 1901.

Some two or three hundred plates of this region are included in the Harvard series, and twenty-nine of them, taken before August 18, have been examined, but no trace of the Nova before that date has been discovered.

Two photographs showing the region half a degree square around the Nova, taken on August 15, 1903, and August 31, 1905, respectively, are reproduced in the Circular, and on comparing them it is at once seen that the Nova does not appear on the former, although it is quite a conspicuous object on the latter plate; stars of magnitude 15·7 are shown on the earlier plate.

Prof. Pickering's tabulated statement of the observed magnitudes of the Nova from August 31 to September 22 shows that this object gradually decreased in brightness from magnitude 10·41 on the first named date to magnitude 11·23 on the second. When first photographed the Nova's magnitude was about 7·0.

It follows from the Harvard observations that the Nova first appeared between August 10 and August 18, but it is hoped that, when the plates taken at Arequipa during that period arrive at Cambridge (Mass.), this interval may be greatly reduced.

STAR WITH A LARGE PROPER MOTION.—The method employed at Harvard College Observatory for the detection of variable stars, viz. the superposition of a photographic plate upon a glass positive of the same region, photographed on an earlier date, has led to the discovery that the star A.G.C. 6886 has a large proper motion. Whilst thus examining two plates of the Large Magellanic Cloud, taken on April 11, 1898, and December 5, 1904, respectively, Miss Leavitt found that this star had moved appreciably during the interval, and a comparison of the positions given in several of the older catalogues compiled since 1825 confirmed the fact.

The discussion of the data obtained from the comparison showed that the annual proper motion in R.A. is $-0{\cdot}066$s., in declination $+1''.14$, and along a great circle $1''{\cdot}28$.

The total number of stars shown on the original negatives is about 300,000, and it is probable that none of these, except A.G.C. 6886, has an annual proper motion exceeding three-quarters of a second (Harvard College Observatory Circular, No. 105).

OBSERVATIONS OF PERSEIDS, AUGUST.—The detailed results of the Perseid observations, made at the meteorological observatory at Pavia on August 8, 9, 10, and 11, are given in No. 8, vol. xxxiv., of the *Memorie della Società degli Spettroscopisti Italiani*.

On the night of August 8–9 seven observers recorded 153 meteors, and determined the trajectories of 23 of them. The maximum horary rate occurred between 0h. and 1h. (August 9), during which time 53 meteors were seen. On the succeeding night the watch lasted from 22h. to 3h. 7m., and the same number of observers saw 252 meteors, of which they recorded the paths of 28. The maximum rate occurred during the last hour, when 93 meteors were seen. The third night produced 264 meteors, and of these the seven observers recorded the trajectories of 18 during their watch of 4h. 56m. The maximum horary rate of the whole shower, as observed at Pavia, was recorded during this watch, when 100 meteors were seen between 2h. and 3h. on the morning of August 11.

Of the 669 meteors seen during the three nights, 27 were recorded as being brighter than, and 139 as being equal to, the first magnitude, whilst "swift" and "white" were the descriptive terms applied to the majority of them.

MATHEMATICAL AND PHYSICAL SCIENCE AT THE BRITISH ASSOCIATION.

THE great number of astronomers present during the South African meeting caused astronomy to play a larger part in the proceedings of the section than it has done in recent years, and many of the most important communications and discussions were on astronomical subjects. The number of papers on pure mathematics and on physics was relatively small.

Of the mathematical papers, one by Prof. Harzer on ancient Japanese mathematics was of special interest. Prof. Harzer finds on examining ancient Japanese records and works that several of the theorems discovered in Europe during the seventeenth century were known at least as early to Japanese mathematicians. As an example, the expansion

$$(\text{arc}\sin y)^2 = \sum_0^\infty \frac{1}{\beta+1} \cdot \frac{2.4.6\ldots 2\beta}{1.3.5\ldots(2\beta+1)} y^{2\beta+2}$$

due to Kowa Seki (1642–1708) may be quoted.

Mr. M. Cashmore showed how chess magic squares, *i.e.* squares of numbers which add up to the same amount along every path across the square in the direction of a rook's, a bishop's, or a knight's move, can be constructed by superposing on each other two types of subsidiary squares, which can be formed by simple rules.

Prof. Perry gave an account of the approximate method he had used to determine the stresses which occur in a winding rope carrying a cage when the upper end of the rope is suddenly stopped.

Mr. H. G. Fourcade described his instrument for stereoscopic surveying. It consists of a photographic camera which may be fixed in turn at the two ends of a base line with its axis perpendicular to that line. In front of, and close to, the sensitive plate a *réseau* scale on a glass plate is placed, and is reproduced on the two photographs taken.

The two are examined together in a measuring machine similar to that used in stellar photography, and by means of micrometer screws any portion of the picture may be made to appear in relief and coincident with an index. The distance of that portion from the base line may then be determined from the micrometer readings. Each determination takes about two minutes, and with a base of 300 metres the probable error does not exceed 1 part in 1000 for a distance of 10,000 metres, and is less for shorter distances.

Prof. Perry raised the question of the teaching of elementary mechanics, and pointed out that the average boy who enters a technical college is so badly educated that his first year has to be "wasted in the study of school subjects." Then three years are found to be insufficient to teach him "everything an engineer is likely to want in his profession," which many colleges foolishly attempt to do, and a fourth or even a fifth year is added. He urged that in teaching science to boys from nine to thirteen the methods of Mr. Barlow, of "Sandford and Merton" fame, should be followed, until they know something of levers, weighing and measuring, specific gravities, barometers and thermometers, and of electricity and magnetism. At the age of fourteen a boy should know elementary algebra and trigonometry, should be able to differentiate and integrate, and apply the calculus. The principles that if forces are in equilibrium their vector sum is zero, and the sum of their moments about any axis is

zero, should be presented to him from many points of view. Force should be taken as the rate of change of momentum. All these facts should be brought out and illustrated by experiment, and it should be the object of the teacher to turn out a pupil with a thorough grasp of mechanical principles, and not one crammed with formulæ which he soon forgets.

With the report of the Mathematical Association committee on the teaching of mechanics Prof. Perry is substantially in accord, although he differs from it in wishing to retain the term "centrifugal force" and to abolish the "poundal."

Lord Kelvin communicated a paper on the kinetic and statistical equilibrium of ether in ponderable matter at any temperature. If two small spheres, one covered with black, the other with white cloth, were placed in space at the earth's distance from the sun, the temperature of the black sphere would be greater than that of the white. If the spheres were at a distance from the sun 1000 times as great, and 999 other suns were scattered through space, all at about that distance from the spheres, the difference of temperature would be one-thousandth of the former difference. Dr. Chree has found, using thermometers, that in bright sunlight the difference of temperature is 1° C. to 3° C. On a starlight night we might therefore expect a difference of 0·001° C. or 0·003° C.

Dr. J. T. Bottomley described his experiments on the cooling of a lamp-blacked or silvered copper sphere in an evacuated spherical copper enclosure kept first at the temperature of liquid air, then, when the sphere has cooled, raised to the temperature of boiling water. Temperatures were observed thermoelectrically. The present results agree with those found previously by Dr. Bottomley, and do not support Stefan's law.

The writer reviewed the recent experimental work on the thermal conductivities of substances, and pointed out that the balance of evidence is in favour of many substances decreasing in thermal conductivity as their temperature is raised.

Mr. A. Word gave a *résumé* of the work done during the past year in the Cavendish Laboratory and elsewhere which justifies the conclusion that all substances are more or less radio-active.

Prof. Beattie described his observations on atmospheric electricity in South Africa, and his attempt to connect the observed conductivity of the air with other meteorological phenomena, an attempt which he considered had proved unsuccessful.

Communications on the meteorology of South Africa by Dr. Mill and by Mr. R. F. Rendall were read, and Prof. Beattie gave an account of the present state of the magnetic survey of the country, and exhibited charts embodying the results for the declination. Necessarily the work has had to be confined to positions near the railways, and it will be necessary to provide some means of extending the field of operations, especially along the western coast of South Africa. The association made a grant of 100*l.* towards the expense of this extension.

Great interest was shown in Sir David Gill's account of the geodetic survey in South Africa and the African arc of meridian. After the completion of the survey of Cape Colony and Natal in 1892, it became necessary to determine with greater accuracy the position of the twentieth parallel of longitude north of the colony at points where it formed the boundary of British and German territory. The work was placed in Sir David Gill's hands by the two Governments, and completed in 1903. At the same time, under the auspices of the Rhodesian Government, surveys of northern and southern Rhodesia were being carried out, partly in connection with the Anglo-Portuguese boundary. Since the war, surveys of the Transvaal and Orange River Colony have made steady progress, and the results so far obtained were embodied in the chart of South Africa exhibited by Sir David Gill. Throughout the work the bases taken were measured with the help of wires which were compared with a standard base 400 feet long before and after use. The discordance in the measurements of the Gwibi base of about 70,000 feet amounted in the aggregate to 1 part in 1·5 millions, and this was the base measured with least accuracy.

As a result, it appears that along the meridian of 19° east longitude the curvature of the earth agrees with that given by Clarke's elements, but along meridian 26° east, and more markedly along meridian 30°, this appears not to be the case. A definite settlement of the question will only be possible after the connection of the Rhodesian triangulation with that of the rest of South Africa, a connection which will entail a cost of about 1600*l.* When this has been achieved, Sir David Gill will have made one step more towards the carrying out of his scheme for a great African arc of meridian extending from the Cape to Cairo, and by combination with the Russian-Scandinavian arc, a great arc from the Cape of Good Hope to the North Cape. The scheme has the hearty approval of Section A.

It is somewhat remarkable that at Cape Town the section should hear an account of a geodetic survey of a country within the Arctic circle, but the details of the geodetic survey of Spitsbergen given by its director, Dr. O. Backlund, proved of great interest. It was undertaken by the Swedish and Russian Governments, was carried out on the same lines as that in South Africa, and has given results of a high order of accuracy considering the difficulties of work in such a country. The values of *g* found at some of the stations in the mountainous parts of the country come out in defect by two or three figures in the fourth place.

One of the most important communications to the section was that of Prof. Kapteyn on star streaming. Prof. Kapteyn finds that the stars, the proper motions of which relative to the solar system have been determined, fall into two groups, one in which the motions take place in the main parallel to a line joining the sun to a point 7° south of α Orionis, the other with its motions parallel to the line joining the sun to a point 2° south of η Sagittarii. If the motions of these two streams be referred to the centre of gravity of the whole of the stars considered, their directions must be diametrically opposite. One of the vertices of these motions in opposite directions Kapteyn finds is close to ξ Orionis, and both lie in the central line of the Milky Way. Prof. Kapteyn does not hold that all motions must be in this line, but that there is a great preponderance of such motions, and that motions oblique to it get fewer the greater the obliquity. At this stage of the investigation he wishes to stand until further knowledge of the motions of stars in the line of sight has been obtained spectroscopically.

Dr. A. W. Roberts gave an account of the observations he has made during the past five years on the light fluctuations of certain southern binary stars, especially V. Puppis. He has succeeded in reaching a high degree of accuracy, and has determined the orbital elements of six stars by means of his observations, using the relations given by Rambaut. He finds the masses of two of the six systems to be 60 to 300 times, and the densities 0·00002 to 0·36 time, those of the sun. The large masses are somewhat exceptional, and Mr. Jeans suggested that the light curves of stars of pear shape would be found to agree with the observations made by Roberts. In support of this, Mr. Jeans gave an account of his investigation of the condensation of a gas occupying initially the whole of space about centres at distances apart approximately equal to that from the solar system to the nearer stars, and with the mass at each centre of the same order as that of the sun. Any one of these nuclei might take a spheroidal, ellipsoidal, or a pear shape, or separate into two parts, according to its velocity of revolution.

Mr. R. T. A. Innes gave an account of the state of double star astronomy in the southern hemisphere, and pointed out the importance of bringing up the observations in the southern to the same state as those in the northern hemisphere. He considers the position and climate of Johannesburg offer exceptional opportunities for the work, and suggested the provision of a telescope by the Transvaal Government. Sir David Gill supported this suggestion.

Of shorter communications it is only necessary to mention a few, *e.g.* Prof. E. W. Brown's on the present state of lunar theory and the necessity of a new set of lunar tables, and Dr. Rambaut's on a new instrument for measuring stellar photographs, to show that in interest and importance the sectional work in South Africa in no way falls behind that of the meetings at home.

C. H. Lees.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE papers contributed to Section B at the meetings in South Africa were naturally more limited in number and in range of subject than is usual at ordinary meetings of the association, the majority of the communications having reference either to the chemical aspects of agriculture or to subjects connected with the gold extracting industry. On the other hand, a very active part in the work of the section was taken by the South African chemists, and, almost without exception, the reading of a paper was followed by an animated and interesting discussion.

At Cape Town, the first day of meeting was set aside for the discussion of agricultural and biochemical questions. As it had been arranged that the presidential address should be delivered at Johannesburg, its place was taken by Mr. A. D. Hall's report on recent developments in agricultural science, in which many subjects of special interest in South Africa were discussed. Dealing with the fixation of atmospheric nitrogen through the agency of bacteria, the author pointed out that a sharp distinction must be drawn between the use of pure cultures on old cultivated lands and in new countries, where leguminous crops are often being grown for the first time, and that the behaviour of the lucerne plant under bacterial infection in South African soils is worthy of careful investigation in view of its economic importance in all semi-arid countries. He directed attention to the need of a systematic series of soil analyses, with the ultimate object of making soil maps that shall be of service to the agriculturist, and indicated how much still remains unknown regarding the nutrition of plants and how great is the importance of research in the particular functions of the various constituents of the crop, as it is only through such knowledge that the quality of crops may possibly be influenced in desired directions. A brief discussion of the subjects of acclimatisation and cross-breeding brought to a close an address which aroused very great interest. Dr. Horace T. Brown then gave an account of his researches on the assimilatory processes of plants, in the course of which he described his method by which the assimilative power of leaves was measured for the first time under natural conditions. The quantity of carbon dioxide abstracted from the air by leaves of measured area was estimated in a special absorption apparatus devised for the purpose, and thus it was possible to deduce the amount of carbohydrate formed. The total solar radiation falling on the leaf was measured, and the proportion of the radiant energy of sunlight absorbed and transmitted by the leaf was also arrived at. The author's investigations showed that the rate of growth is not entirely dependent upon the amount of sunshine, but also on secondary causes. The business was brought to a close by a short paper by Dr. E. F. Armstrong on the *rôle* of enzymes in plant economy, in which the author directed attention to the fundamental similarity between the action of acids and that of enzymes, the distinction between them arising from the fact that enzymes act selectively in consequence of their power of associating themselves with the hydrolyte. The condition of the carbohydrate in solution is of primary importance, but this condition may to some extent be determined by the enzyme.

At the second day's meeting, Prof. H. B. Dixon gave a historical sketch of researches made on the propagation of explosions in gases, and discussed Berthelot's theory and his own "sound wave" theory on the mode of propagation. With the aid of the lantern he showed how he had followed photographically the flame from its initiation until the setting up of the detonation, and demonstrated the influence of the position of the spark and of the length of the column of exploding gases. He also described experiments now in progress on the specific heats of gases at high temperatures, and explained how the velocity of sound in a heated gas may be determined. In a second paper Prof. Dixon described the method he has devised for determining the atomic weight of chlorine by the direct burning of a known weight of hydrogen in a known weight of chlorine, the hydrogen, prepared by the electrolysis of barium hydroxide, being occluded in palladium, and the chlorine, prepared by the electrolysis of fused silver chloride, being weighed in the liquid state. The atomic weight obtained is higher than that of Stas, but in close agreement with the recent results of Richards. Messrs. G. T. and H. W. Beilby gave an account of their experiments on the influence of phase changes on the tenacity of ductile metals at the ordinary temperature and at the boiling point of liquid air. They showed that when a wire of ductile metal is stretched to four or five times its original length by drawing it through the holes of a wire plate all the ordinary traces of crystalline structure disappear, but the wire still consists of minute granules of the crystalline phase embedded in a matrix of the amorphous phase. By lowering the temperature of drawing, the mixture approaches more nearly to the homogeneous amorphous state. Observations were made at 15° and at −180° on wires of copper, silver, and gold, which had been as completely as possible converted into the amorphous phase by wire drawing at the ordinary temperature, and in every case the tenacity observed was higher than any recorded by previous investigators for equally pure metals. The wires broken at the ordinary temperature showed no general stretching, but at the boiling point of liquid air all the wires stretched about 12 per cent. Dr. A. Midlay recorded his determinations of the viscosities of liquid mixtures at the temperature of their boiling points, which were made in the expectation that viscosity curves would be obtained similar in form to the boiling-point curves. In the case of benzene and methyl alcohol, the viscosities of which at the respective boiling points are nearly the same, the expectation appears to be realised, but where the viscosities of the pure liquids at their boiling points are not the same certain complications are met with.

The third day of meeting at Cape Town was set apart for communications from local chemists. Prof. P. D. Hahn gave an account of the remarkable thermal chalybeate spring at Caledon, in Cape Colony. With the aid of a tabular statement of the purity ratio of the most famous chalybeate springs, he showed that the Caledon water holds with the water of Spa the first place, but he pointed out that while the waters of most chalybeate springs are very low in temperature, the Caledon spring is unique in so far that the temperature of the water at the eye of the spring is 49° C. Mr. C. F. Juritz stated that for various reasons very scanty attention has hitherto been paid to purely scientific chemical research in Cape Colony, and gave an interesting account of several investigations made in the Government laboratory under his direction. A chemical survey of the soils of the colony (at present suspended for want of funds) has resulted in the examination of an area of 27,000 square miles, on an average one sample being taken for every 60 square miles. A number of the fodder plants of the Karroo have been examined as regards their nutritive value, estimations of tannin in the barks of various trees have been made, poisonous principles have been extracted from some indigenous plants, and an alkaloid resembling quinine therapeutically, but differing from it chemically, has been extracted from the umjela or quinine tree, which abounds in the Transkei. Clays have been found in various parts of the colony some of which compare favourably in chemical composition with the best fire clays, and mineral pitch has been observed in certain localities. Dr. H. Tietz, in a paper on the character of Cape wines, explained that at the Cape grapes always become perfectly ripe, and thus contain more sugar and less acid than the grapes of the wine-producing countries of Europe. Notwithstanding this, a standing reproach against Cape wines is based on the contention that they contain more acid than European wines. The author investigated this matter on some 300 samples of different Cape wines, and found that the allegation cannot be upheld.

At Johannesburg the proceedings of the section were inaugurated by the delivery of the address of the president, which was of quite exceptional interest. It was followed by a paper by Mr. H. F. Julian, in which an investigation of the part played by oxygen in the dissolution of gold by cyanide solutions was described. The author arrived at the conclusion that free oxygen plays no primary part in the reaction, any assistance given being of a secondary nature, and that, as a matter of fact, it exerts a retarding influence. According to his experiments, while the balance indicates that free oxygen is of material assist-

ance, the galvanometer points to its presence hindering the dissolution of the gold; the cause of the disagreement between the instruments he attributes to the formation of local voltaic circuits. Mr. H. A. White gave an account of a series of experiments which showed that thiocyanates in presence of such oxidising agents as ferric salts attack gold with considerable ease, and that thiosulphates exert a similar but less powerful influence. These salts are present in ordinary working cyanide solutions, and the presence of gold in mine reservoirs and in the soil under residue dumps is probably connected with their occurrence. Experiments adduced by the author indicate that in well exposed dumps thiocyanates alone are of significance in respect to the observed solution of gold. A process of residue treatment, based on these facts, is resulting in the profitable extraction of a large proportion of the gold in certain of the residue dumps on the Rand.

At the second day's meeting, Dr. J. Moir discussed the law governing the solubility of zinc hydroxide in alkalis, and as the result of a quantitative research stated the conclusion that the phenomenon is essentially an equilibrium between alkali and zincic acid, which may be reached from both sides, and which depends solely on the concentration of the free alkali. It was also shown that no definite chemical compounds exist in the solution. Mr. G. W. Williams read a paper on the functions of the metallurgical laboratory, dealing with the uses of the laboratory for the testing of supplies and for purposes of research, and with the *personnel* and equipment of a suitable laboratory. He emphasised the necessity for a highly trained staff, and pointed out defects in the training given in the great English universities. In a valuable contribution, Mr. S. H. Pearce stated and discussed various economic problems in metallurgy on the Rand. Each stage of the whole process of gold extraction was considered from the economic as well as from the scientific standpoint, and the results of the practical experience of years were summarised in a very clear and judicial manner. Much technical information, of value to all interested in gold extraction, was given in this paper. Mr. R. L. Cousens gave an account of the experiments which led him to conclude that a radio-active substance is present in a certain ore discovered in the Transvaal. If a further examination of the material confirms his belief that the radio-activity of the ore is due to the presence of radium, the result will be of interest in view of the fact that uranium is not present in the ore.

The third day of the meeting was devoted to agricultural chemistry. The proceedings were opened by Mr. A. D. Hall, who discussed in greater detail some of the problems touched on in his address at Cape Town. In a paper on Pretoria rain, Mr. H. Ingle stated that the rain falling at Pretoria for twelve months from February, 1904, was collected, and its content of nitrogen, existing as nitrates, nitrites, and ammonia, determined each week. The results showed that the quantity of combined nitrogen brought down in the rain at Pretoria is considerably greater than the average amounts in Europe, amounting in twelve months to 7·07 lb. of nitrogen per acre as compared with the average of 3·84 lb. per acre at Rothamsted. In a second paper Mr. Ingle communicated the results of the analyses of some eighty samples of soils collected in various parts of the Transvaal, and drew a comparison between European and Transvaal soils, with special reference to the interconnection of their chemical composition and fertility as indicated by field experience. He showed that to take English standards in judging of fertility from chemical analysis may lead to erroneous conclusions in the case of tropical or subtropical soils, and that if there be a sufficient supply of water a soil of apparently poor quality, from analytical results, may yield luxurious crops under the favouring conditions of growth existent in the Transvaal. Mr. E. H. Croghan, in a paper on the fuel of the midland districts of South Africa, pointed out that a large proportion of potash is found in the excreta of sheep fed in this dry and treeless region, resulting from the composition of the bushes, the foliage of which constitutes the chief food of sheep and cattle. Owing to want of water for irrigation the farmer does not use sheep excreta for manure, but for fuel, and the ashes frequently accumulate near the homestead. Attention was directed to the economic value of these ash heaps, either as a manure or as a source of potassium carbonate. Reports were presented by the committee on wave-length tables of the spectra of the elements, the committee on the study of hydro-aromatic substances, and the committtee on the transformation of aromatic nitroamines.

SCIENTIFIC RESEARCH IN MEDICINE.[1]

THAT great benefits to mankind have followed the discoveries of recent years is obvious to all, especially with regard to the causes and prevention of yellow fever and malaria. Research is a word heard on all sides; it is the enemy of authority, that tyrannous spirit which has hampered progress and retarded the advance of scientific medicine for centuries. Experimental medicine is responsible for the greatest advances which have been made in our knowledge of the cause, prevention, and cure of disease. Most important discoveries have exerted but a slight direct influence at their inception; their full significance has remained hidden for a time. The majority of such discoveries has been made by those engaged in research in the realms of pure science. Pure science is unselfish; its aim is not profit, yet it is the forerunner of that applied science which is more obtrusively the "servant of man." If we study disease, we must do so for the sake of knowledge, the scientific spirit must enter into our work. The "practical man" may not appreciate such ideals, but he is ever ready to use the discoveries of science for his own ends. All are not born with the instincts of research, but there are many in whom they lie dormant, and it should be the function of educational institutions to detect and foster such men and lead them on to do the work for which they are adapted. But too often from mere lack of means such men drift away into other fields of activity. To carry on research successfully a man needs an assured income. Is it possible that those who are able and willing to help human progress can continue to ignore the devotion and self-sacrifice of such men as Lazear, Myers, Dutton, Plehn, and others who have laid down their lives in the study of tropical medicine? Medical research needs endowment, and it is grievous to see that in this country, where so much is done for charity, so pitiably little is done for the advancement of learning. To teach science as it should be taught in properly equipped and organised institutions is far more expensive in the case of medicine than in that of any other professional school. It does not suffice to build laboratories; they must also be provided with sufficient funds and equipment to enable them to become working entities.

Those who have watched the progress of the London School of Tropical Medicine from its inception have witnessed a struggle upward which is worthy of all praise. This, and the sister institution in Liverpool, are known throughout the world for the excellent work accomplished by the members of the teaching staff and by some of the students they have sent forth. The London School has a great mission to fulfil; it has to train men in the methods they will be called on to employ in many parts of the world, and to give them the latest and the best to take with them on their distant journeys. It is to be hoped that the public will second the noble efforts that have been made to establish a centre for the study of the diseases which affect the inhabitants of the tropical countries of this vast Empire.

The Trend of Recent Investigation.

A survey of recent work in tropical medicine shows us that investigation is chiefly being directed to the study of protozoal diseases. No advances of fundamental importance have been made with regard to malaria since the classical investigations were published with which the names of Ross and Manson, Grassi, Bignami and Bastianelli will ever remain associated. The earlier work has been confirmed and extended by many investigators. The prevention of malaria by means of mosquito destruction and other measures directed against mosquitoes has been tried in various localities, in some instances with success,

[1] From an address delivered at the opening of the nineteenth session of the London School of Tropical Medicine on October 11, by Dr. George Nuttall, F.R.S.

in others with doubtful results. This is, however, only what might be expected in view of the diversified difficulties which must necessarily arise.

There has been a veritable flood of malaria literature of recent years, including an annual volume of "Atti della Società per gli studi della malaria," the series commencing in 1900, which has come to us from Italy. Mosquitoes have received an immense amount of attention, after being much neglected in the past. The number of genera and species and their classification have become subjects to bewilder all but specialists.

The important discoveries on sleeping sickness ushered in by the researches of Castellani, a pupil of this school, have been confirmed and extended by Bruce and his collaborators of the sleeping sickness commission. The relation of the flies belonging to the genus Glossina to the transmission of the trypanosomes is being actively studied, and many important questions we must hope are nearing their solution in connection with this most fatal malady. A contribution has just come to hand from Gray and Tulloch with regard to the multiplication of the parasites in Glossina, indicating that the belief recently expressed is warranted, namely, that the parasites undergo a cycle of development within the insects. Of importance in their bearing on the question of the development of trypanosomes in other than their vertebrate hosts are the investigations of Schaudinn on *Trypanosoma noctuae* in Culex, those of Brumpt on certain trypanosomes of fishes which undergo their cycle of development in leeches, and those of Prowazeck on the rat trypanosome, which he has demonstrated undergoes development in the rat louse (*Haematopinus spinulosus*).

Of recent discoveries, the one which to me appears to carry the greatest weight is that of Novy and McNeal. They have been the first to obtain pure cultures of Protozoa, maintaining trypanosomes of different species alive *in vitro* for many generations. There is no telling whither the methods they have given us may lead; they directly stimulated Leonard Rogers to experiments wherein he succeeded, by an ingenious method of his own, in cultivating another protozoon, the Leishmania, obtained from cases of kala-azar.

The work on the tick-transmitted diseases known as the piroplasmoses (redwater, &c.) occurring in cattle, sheep, horses, and dogs has been pursued in various parts of the world with great activity. The results appear to me to indicate, what I believe also holds for human malaria parasites, that we shall in time learn to distinguish different parasites which we at present consider to represent single species.

The investigations of Dutton and Todd on tick fever in the Congo Free State, announced in February, have gone to prove that this disease is transmitted by a tick (*Ornithodoros savignyi*) after it has infected itself with blood containing the Spirochætæ. This has been confirmed by Koch, if we may rely on what has appeared recently in German newspapers. It is, however, quite premature to assume that African tick fever and European relapsing fever are due to one and the same species of Spirochæta; in fact, it is highly probable that this is not the case, although the report in question refers to the Spirochætæ as one species. In relapsing fever in Europe the bedbug (Cimex) has long been suspected to be a carrier of the infective agent, a probability which was considerably heightened by Karlinski's observation of motile Spirochætæ in the bodies of the insects up to thirty days after they had fed on relapsing fever blood. Schaudinn, moreover, informs me that he has observed the multiplication of the *Spirochaeta obermeieri* in Cimex. These observations, following closely upon those published by Marchoux and Salimbeni, are of greatest interest and practical import. The last named authors demonstrated that a fatal disease of the fowl in Brazil is due to a Spirochæta which is transmitted through the agency of a tick (*Argas miniatus*), and this is capable of conveying the disease even six months after feeding on infected blood. These Spirochætæ multiply in the tick, and are present in large quantities in its body cavity throughout this period. These observations are very suggestive, since they demonstrate the long persistence of the parasites in their carriers, and render it probable that they will be found to be harboured much longer. Finally, the finding this year of *Spirochaeta pallida* in syphilis by Schaudinn and others in man, and by Metschnikoff and Roux in experimentally infected apes, cannot escape a passing notice.

It is of some interest to note that the close blood-relationship existing between the apes and man, demonstrated independently by means of the precipitins by Grünbaum and myself, served as a direct incentive for the experiments of Metschnikoff and Roux, Lassar, and Neisser, which proved that human syphilis is communicable to the chimpanzee and ourang outang.

Of interest has also been the further discovery this year of a number of new protozoal parasites in the blood of different animals, in addition to numerous new species of Trypanosoma. I refer to new forms called "Leucocytozoa" because they inhabit the white blood corpuscles of their vertebrate hosts. Leucocytozoa were first discovered by Bentley in dogs in India, and were described, without sufficient mention of this fact, by James. Another species has been found by A. Balfour in the rat (*M. decumanus*) in Khartoum; and lastly, W. S. Patton informs me that he has found a species in the squirrel (*Sciurus palmarum*) in India, and apparently observed developmental forms thereof in a louse. Balfour has, moreover, described a new Hæmogregarine occurring in the jerboa (*Jaculus jaculus*), and Graham-Smith in our laboratory has found another new endoglobular parasite in the mole. This by no means exhausts the "finds" of this year, but it will suffice to show that British workers are doing their share in furthering our knowledge in this regard.

Of the diseases due to Vermes I can say but little. The discovery of Catto's Schisostomum in this laboratory is familiar to you all. It is interesting to note, following on the experiments with *Ankylostoma duodenale* by Loos, proving that the embryo worm can infect by penetrating through the skin, that Boycott in London and Tenholt in Germany have confirmed the fact this year in two experiments conducted on medical men who volunteered for the purpose.

Again, it is apparent that the subject of immunity in relation to protozoal diseases is proving to be one of great difficulty, and the results hitherto obtained indicate that new methods will have to be devised if the problem is to be solved from a practical, and still more so from a scientific, standpoint. It is also obvious in this connection that the problems before us can only be solved by animal experiment, and this accentuates the need of our giving an increasing amount of attention to comparative pathology as we push on toward the alleviation of the ills to which our own flesh is heir.

Many matters have necessarily been left untouched, including even such important diseases as yellow fever and Malta fever, on which active work has been done. My object has been to seize upon a few salient facts with the view of showing how much has been accomplished within a short period, and how great are the opportunities of the workers in this school who are destined to labour in new fields in different parts of the world. Perhaps what I have said—in no spirit of presumption—will serve as an incentive to some of my hearers. Let me conclude with some wise words from the Talmud:—

> "The day is short and the work is great.
> It is not incumbent upon thee to complete
> the work, but thou must not therefore
> cease from it."

THE MECHANICS OF THE ASCENT OF SAP IN TREES.[1]

THE following remarks, relating to one of the most powerful and universal of the mechanical operations of organic nature, are based mainly on the numerous experimental results reported in Dr. A. J. Ewart's recent memoir.[2] Their chief object is to assert the view that we are not compelled to suppose the sap, in the column of vessels through which it rises, to be subject to the great actual pressure, amounting in high trees to many atmospheres, that is sometimes postulated. It is hardly

[1] By Prof. J. Larmor, Sec.R.S. Paper received at the Royal Society on June 29.

[2] *Roy. Soc. Proc.*, vol. lxxiv. p. 554; *Phil. Trans.*, B, vol. cxcviii. p. 41.

necessary to remark that the problem of the rise of sap is one of mechanics, in so far as concerns the mode of the flow and the propelling power.

Contrary to the view above referred to, it seems not unreasonable to consider that the weight of the sap in each vessel is sustained in the main by the walls and base of that vessel, instead of being transmitted through its osmotically porous base to the vessels beneath it, and thus accumulated as hydrostatic pressure.

We could in fact imagine, diagrammatically (as happens in ordinary osmotic arrangements), a vertical column of vessels, each provided, say, with a short vertical side-tube communicating with the open air, in which the pressure is adjusted from moment to moment, and yet such that the sap slowly travels by transpiration from each vessel to the one next above, through the porous partitions between them, provided there is an upward osmotic gradient, *i.e.* if the dissolved substances are maintained in greater concentration in the higher vessels.[1] This difference of density must be great enough, between adjacent vessels, to introduce osmotic pressure in excess of that required to balance the head of fluid in the length of the upper one, into which the water has to force its way. Thus, in comparing vessels at different levels, the sap must be more concentrated in the upper ones by amounts corresponding to osmotic pressure more than counteracting the total head due to difference of levels, in order that it may be able to rise. As osmotic pressure is comparable with gaseous pressure for the same density of the molecules of the dissolved substance, the concentration required on this view is considerable, though not very great.

Such a steady gradient of concentration could apparently, on the whole, become self-adjusting, through assistance from the vital stimuli of the plant, for concentration in the upper vessels is promoted by evaporation. Yet pressures in excess or defect of the normal atmospheric amount might at times accumulate locally, the latter giving rise to the bubbles observed in the vessels, through release of dissolved gases.

It may be that this assumes too much concentration of dissolved material in the sap, *as it exists inside the vessels of the stem,* to agree with fact. In that case the capillary suction exerted from the nearest leaf-surface might be brought into requisition, after the manner of Dixon and Joly, to assist in drawing off the excess of water from the vessels. The aim proposed in this note is not to explain how things happen, which is a matter for observation and experiment, but merely to support the position that nothing abnormal from the passive mechanical point of view need be involved in this or other vital phenomena.

As regards estimating the amount of flow, at first sight it may not appear obvious, *a priori,* that the transpiration through a porous partition or membrane, due to osmotic gradient, is equal or even comparable in amount to what would be produced, with pure water, by a hydrostatic pressure-head equal to the difference of the osmotic pressures on the two faces of the partition. But more exact consideration shows that, on the contrary, osmotic pressure is *defined* by this very equality;[2] it is that pressure-difference which would produce such an opposite percolation of water as would just balance the direct percolation due to the osmotic attraction of the salt-solution.

[1] Thus, in an ordinary osmotic experiment with a **U**-tube, the percolation of water through the plug gradually *produces* a difference of hydrostatic pressure on its two faces, which is *sustained* by the fixity of the plug itself, but would be at once neutralised if the plug were free to slide in the tube. This increase of volume of the salt-solution, by the percolation of pure water into it, is on the van 't Hoff analogy correlated with the free expansion of the molecules constituting a gas. It goes on with diminished speed under opposing pressure, until a definite neutralising pressure is reached, inaptly called the osmotic pressure of the molecules of the solute, which just stops it, while higher pressures would reverse it. The stoppage is due to the establishment of a balance between the amounts of water percolating one way under osmotic attraction, and the opposite way under hydrostatic pressure. The pressure established, *e.g.* in an organic cell immersed in salt-solution, is thus really the reaction which is set up against the osmotic process. That process itself is perhaps more directly and intelligibly described as the play of osmotic affinity or attraction, even though it must be counted as of the same nature as the affinity of a gas for a vacuum. *Cf. Proc. Camb. Phil. Soc.*, January, 1897, or Whetham's "Theory of Solution," p 109.

[2] See preceding footnote.

It would, however, appear that the great resistance to flow offered by what botanists call Jamin-tubes, *viz.* thin liquid columns containing and carrying along numerous broad air-bubbles, is conditioned mainly by the viscosity of the fluid, and involves only indirectly the surface-tension of the bubbles. In fact, the resistance to flow may be expected to remain much the same if each bubble were replaced by a flat solid disc, nearly but not quite fitting the tube. Its high value arises from the circumstance that the mass of liquid between two discs moves on nearly as a solid block when the flow is steady, so that the viscous sliding has to take place in a thin layer close to the wall of the tube, and is on that account the more intense, and the friction against the tube the greater. The increased curvature of the upper capillary meniscus of the bubble is thus merely a gauge of the greater intensity of the viscous resistance instead of its cause, and modification of the surface-tension cannot be involved as a propelling power. The experimental numbers given by Dr. Ewart show that, even where the vessels are largely occupied by bubbles, the greater part of the resistance to active transpiration still resides in the partitions between them.

If the osmotic gradient, assisted possibly by capillary pull at the leaf-orifices, is insufficient to direct a current of transpiration upward, *capillary* alterations inside the vessels, arising from vitally controlled emission and absorption of material from the walls, cannot be invoked to assist: rather it must be *osmotic* alterations from one vessel to the next, of, so to speak, a peristaltic character, that might thus come into play. But any such alteration (of either kind) will involve local supply of energy. Is there a sufficient fund of energy, latent in the stem, to provide permanently the motive power for the elevation of the sap? In what form could this energy get transported there? The energies of the plant-economy come from the sunlight absorbed by the leaves. The natural view would appear to be that the work required to lift the sap is exerted at the place where the energy is received, and that it operates through extrusion of water by evaporative processes working against the osmotic attraction of the dissolved salts; while the maintenance of equilibrium along the vessels of the balanced osmotic column, with its semi-permeable partitions, demands that an equal amount of water must rise spontaneously to take the place of what is thus removed.

The subject might, perhaps, be further elucidated by observation of the manner in which the flow is first established at the beginning of the season, or possibly by experiments on the rate at which water would be absorbed by a wounded stem high above the ground.

EXPERIMENTS WITH THE LANGLEY AËRODROME.[1]

THE experiments undertaken by the Smithsonian Institution upon an aërodrome, or flying machine, capable of carrying a man have been suspended from lack of funds to repair defects in the launching apparatus without the machine ever having been in the air at all. As these experiments have been popularly, and of late repeatedly, represented as having failed on the contrary, because the aërodrome could not sustain itself in the air, I have decided to give this brief though late account, which may be accepted as the first authoritative statement of them.

It will be remembered that in 1896 wholly successful flights of between one-half and one mile by large steam-driven models, unsupported except by the mechanical effects of steam engines, had been made by me. In all these the machine was first launched into the air from "ways," somewhat as a ship is launched into the water, the machine resting on a car that ran forward on these ways, which fell down at the extremity of the car's motion, releasing the aërodrome for its free flight.

In the early part of 1898 the Board of Ordnance and Fortification of the War Department allotted 50,000 dollars for the development, construction, and test of a large aëro-

[1] Abridged from a paper by Dr. S. P. Langley in the Smithsonian Report for 1904.

drome, half of which sum was to be available immediately and the remainder when required.

The flying weight of the machine complete, with that of the aëronaut, was 830 pounds; its sustaining surface, 1040 square feet. It therefore was provided with slightly greater sustaining surface and materially greater relative horse-power than the model subsequently described which flew successfully. The brake horse-power of the engine was 52; the engine itself, without cooling water, or fuel, weighed approximately 1 kilogram to the horse-power. The entire power plant, including cooling water, carburettor, battery, &c., weighed materially less than 5 pounds to the horse-power. Engines for the large machine and for a model of the large machine one-fourth of its linear dimensions were completed before the close of 1901, and they were immediately put in their respective frames, and tests of them and of their power-transmission appliances were begun.

A test of the quarter-size model in actual flight was made on August 8, 1903, when the machine worked most satisfactorily, the launching apparatus, as always heretofore, performing perfectly, while the model, being launched directly into the face of the wind, flew directly ahead on an even keel. The balancing proved to be perfect, and the power, supporting surface, guiding, and equilibrium-preserving effects of the rudder also. The weight of the model was 58 pounds, its sustaining surface 66 square feet, and the horse-power from $2\frac{1}{2}$ to 3. This was the

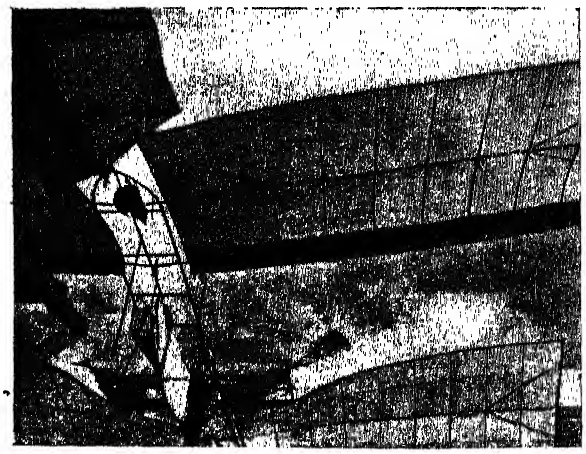


FIG. 1.—Reproduction of an instantaneous photograph, taken from the boat itself and hitherto unpublished, showing the aërodrome in motion before it had actually cleared the house boat. On the left is seen a portion of a beam, being a part of the falling ways in which the front wing was caught, while the front wing itself is seen twisted, showing that the accident was in progress before the aërodrome was free to fly.

first time in history, so far as I know, that a successful flight of a mechanically sustained flying machine was made in public.

Serious delays in the testing of the small machine were caused by changed atmospheric conditions, but they proved to be almost negligible compared with what was later experienced with the large one.

On October 7, 1903, the weather became sufficiently quiet for a test. In this, the first test, the engineer took his seat, the engine started with ease and was working without vibration at its full power of more than 50 horse, and the word being given to launch the machine, the car was released and the aërodrome sped along the track. Just as the machine left the track, those who were watching it, among whom were two representatives of the Board of Ordnance, noticed that the machine was jerked violently down at the front (being caught, as it subsequently appeared, by the falling ways) (Fig. 1), and under the full power of its engine was pulled into the water, carrying with it its engineer. When the aërodrome rose to the surface it was found that while the front sustaining surfaces had been broken by their impact with the water, yet the rear ones were comparatively uninjured. As soon as a full examination of the launching mechanism had been made it was found that the front portion of the machine had caught on the launching car, and that the guy post, to which were fastened the guy wires which are the main strength of the front surfaces, had been bent to a fatal extent. The machine, then, had never been free in the air, but had been pulled down as stated.

On December 8, 1903, a test was made at Arsenal Point, quite near Washington, though the site was unfavourable. The engine being started and working most satisfactorily, the order was given by the engineer to release the machine, but just as it was leaving the track another disaster, again due to the launching ways, occurred. This time the rear of the machine, in some way still unexplained, was caught by a portion of the launching car, which caused the rear sustaining surfaces to break, leaving the rear entirely without support, and it came down almost vertically into the water.

Entirely erroneous impressions have been given by the account of these experiments in the public Press, from which they have been judged, even by experts, the impression being that the machine could not sustain itself in flight. It seems proper, then, to emphasise and to reiterate, with the view of what has just been said, that the machine has never had a chance to fly at all, but that the failure occurred on its launching ways; and the question of its ability to fly is consequently, as yet, an untried one.

There have, then, been no failures so far as the actual test of the flying capacity of the machine is concerned, for it has never been free in the air at all. The failure of the financial means for continuing these expensive experiments has left the question of their result where it stood before they were undertaken, except that it has been demonstrated that engines can be built, as they have been, of little more than one-half the weight that was assigned as the possible minimum by the best builders of France and Germany; that the frame can be made strong enough to carry these engines, and that, so far as any possible prevision can extend, another flight would be successful if the launching were successful; for in this, and in this alone, so far as is known, all the trouble has come.

The experiments have also given necessary information about this launching. They have shown that the method which succeeded perfectly on a smaller scale is insufficient on a larger one, and they have indicated that it is desirable that the launching should take place nearer the surface of the water, either from a track upon the shore or from a house boat large enough to enable the apparatus to be launched at any time with the wings extended and perhaps with wings independent of support from guys. But the construction of this new launching apparatus would involve further considerable expenditures that there are no present means to meet; and this, and this alone, is the cause of their apparent failure.

Failure in the aërodrome itself or its engines there has been none; and it is believed that it is at the moment of success, and when the engineering problems have been solved, that a lack of means has prevented a continuance of the work.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The number of first-year students matriculated on Saturday, October 21, was 1008. Last year at the same date the number was 884. With those matriculated during the Lent and Easter terms, the total for the civil year 1905 is 1039; but this number will be slightly increased, as several freshmen were unable to attend on Saturday. Hitherto the largest entry has been 1027, in the year 1890. The number of medical students is 117; there is also a large entry of engineering students and of candidates for the economics tripos.

The professor of mineralogy has, with the consent of the Vice-Chancellor, re-appointed Mr. A. Hutchinson, of Pembroke College, to be demonstrator in mineralogy and assistant curator for five years from January 1, 1906.

The special board for biology and geology has nominated Mr. F. A. Potts, of Trinity Hall, to use the university table at Naples for six months as from October 1, 1905.

A university lectureship in mathematics is vacant by the resignation of Mr. Jeans, who has accepted a professorship at Princeton University, New Jersey. The general board of studies will shortly proceed to appoint a lecturer to hold office from Christmas, 1905, until Michaelmas, 1910. The annual stipend is 50*l*. The lecturer will be expected to lecture on applied mathematics. Candidates are requested to send in their applications, with statements of the branches of mathematics in which they are prepared to lecture, and with testimonials if they think fit, to the Vice-Chancellor on or before November 6.

Science announces that New York University has received 5000*l*. by the will of the late William A. Wheelock.

SOME excellent views of the plant and equipment of the workshops and laboratories at Birmingham University are given in illustration of a series of articles by Mr. C. Alfred Smith in *Engineering*.

DR. ALEXANDER MCKENZIE, lecturer and senior demonstrator in the University of Birmingham, has been appointed head of the chemical department at the Birkbeck College in succession to Dr. John E. Mackenzie, who has accepted the appointment of principal of the Technical Institute, Bombay.

THE Ontario Government has selected, says *Science*, the following men to compose a commission to report on the proposed reorganisation of the University of Toronto:—Prof. Goldwin Smith, Sir William Meredith, Messrs. A. H. N. Colquhoun, Byron E. Walker, J. W. Flavelle, the Rev. Canon Cody, and the Rev. D. B. Macdonald.

THE classes in craft instruction in photography and process work at the Regent Street Polytechnic were inaugurated by a social re-union on October 17. We notice the time-table for the present session includes classes in practical and technical photography, studio operating, retouching, finishing in colours, photo-engraving, and in colour photography.

THE Bishop of Birmingham, delivering the presidential address to the members of the Midland Institute at Birmingham on October 13, took for his subject "What is an Educated Man?" He said the uneducated man is without an ideal, consciously held and deliberately striven after. He may be a specialist of trained faculty, but, if he has no general ideal enabling him to give his special subject its place in human progress as a whole, he remains a trained specialist rather than an educated man. The educated man knows something of modern scientific method and achievement. Then the world becomes to him the scene of great constant forces which admit of being guided and directed and combined to promote the purpose of human progress. A man to become educated need not have time to read much, if he reads the right books. He ought to know some one other language than his own, and enlarge his study in some other literature. A man who has read carefully any one of the works of Darwin will know what real scientific caution is, coupled with the widest power of hypothesis.

A COPY of the annual report of the Glasgow and West of Scotland Technical College has been received. The total expenditure to date on the site, building, and equipment of the first section of the new building, the memorial stone of which was laid by the King two and a half years ago, has been 163,060*l*.; the building and equipment fund now stands at 209,763*l*., of which 198,845*l*. has been received. The small balance available after payment of the liabilities already incurred is not sufficient to enable the governors to proceed with the remaining section of the building, but it is hoped that they will soon be placed in a position to complete the scheme originally proposed. In addition to the subscriptions to the building and equipment fund, the college will receive a legacy of 20,000*l*. under the will of the late Mr. James Donald, and also the residue of his estate. This welcome addition to the resources of the college is to be used in the development of the facilities already existing for the study of chemistry and mechanics. The scheme for the coordination of certain of the continuation classes conducted by the school boards of Glasgow and Govan with the corresponding classes in the college was in force during last session, but did not work so satisfactorily as was anticipated. The necessity for a closer linking together of the two systems was felt, and an officer of the college has been appointed as superintendent of the continuation classes concerned, whose principal duty is to keep in close touch with the teachers, both of the college and the school boards, and whose active mediation will, it is hoped, secure the carrying out of the scheme of work agreed upon.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 5.—Mr. F. Merrifield, president, in the chair.—Mr. E. **Harris** showed living larvæ of *Cordylomera saturalis*, taken from a log of mahogany imported from the Sekondi district of the Gold Coast, together with the perfect beetle, which was dead at the time the discovery was made.—Mr. A. T. **Rose** exhibited a remarkable melanic specimen of *Catocala nupta*, taken by Mr. Lewis in his garden at Hornsey, N., in September. The coloration of the lower wings was of a dull brown, and all the markings of the upper wings were strongly intensified.—Mr. N. H. **Joy** brought for exhibition Coleoptera taken during a three days' trip to Lundy Island in August, including *Melanophthalma distinguenda*, Con., a species new to Britain; *Stenus ossium* var. *insularis*, a variety apparently new to science; and *Ceuthorrhynchus contractus* var. *pallipes*, Crotch, peculiar to the island. One hundred and sixty-three species were taken on the island, about eighty of which are not recorded in Wollaston's and F. Smith's lists of Lundy Coleoptera.—Mr. A. **Sich** showed examples of *Argyresthia illuminatella*, Z., two of the four specimens taken near Hailsham, Sussex, on June 15 this year. They were beaten off Pinus, and until examined with a lens were supposed to be *Ocnerostoma piniariella*, of which species two were also exhibited for comparison.—Mr. W. J. **Lucas** exhibited the larva, cocoon, and the subsequent imago of an "ant-lion," *Myrmeleo formicarius*, from two Spanish larvæ given him by Dr. T. A. Chapman last autumn. The difference in size between the small larva and the large perfect insect was remarkable. He also showed a living ♀ of the rather scarce grasshopper *Stenobothrus rufipes*, taken in the New Forest at the end of August, and kept alive by feeding on grass.—Mr. G. C. **Champion** exhibited several examples of *Lymexylon navale*, L., from the New Forest, where it was not often found.—Mr. A. H. **Jones** showed series of *Lycaena argus* (*aegon*, Schiff.), var. *hypochiona*, taken on the North Downs this year, approaching the form of *L. argyrognomon* taken not uncommonly in the Rhone Valley. Together with these he had arranged for comparison typical British *L. argus*, L., *L.* var. *corsica*, from Tattone, Corsica, and a series of *L. argyrognomon*, Brgstr. (*argus*, auctorum), from Chippis, near Sierre.—Colonel J. W. **Yerbury** exhibited specimens of *Hammerschmidtia ferruginea*, Fln., from Nethy Bridge, the first authentic British specimens; also *Microdon latifrons*, Lw., a specimen of which, taken at Nethy Bridge June 18, 1900, he had wrongly identified as *M. devius*, and under this name it was recorded in Verrall's "British Flies"; and of *Chamaesyrphus scaevoides*, Fln., a single specimen swept on June 15 in the Abernethy Forest near Forest Lodge.—Mr. H. J. **Turner** exhibited series of four species of the genus Coleophora, *C. alcyonipennella*, *C. lixella*, *C. albitarsella*, and *C. badiipennella*, together with the larval cases mounted *in situ* on the ruined leaves of their respective food plants. He also exhibited living larvæ and their cases, of *Goniodoma limoniella* on *Statice limonium*, *Coleophora obtusella* on *Juncus maritimus*, and *C. glaucicolella* (?) on *Juncus glaucus*, found in the Isle of Wight.—Commander J. J. **Walker** read a paper by Mr. A. M. Lea entitled "The Blind Coleoptera of Australia and Tasmania," and exhibited specimens of *Illaphanus stephensi*, Macl., from Watson's Bay, Sydney, N.S.W., and *Phycochus graniceps*, Broun, and *P. sulcipennis*, Lea, from Hobart, Tasmania.

MANCHESTER.

Literary and Philosophical Society, October 17.—Sir William H. Bailey, president, in the chair.—The "shadow bands" seen during the total eclipse observed at Burgos, in Old Castile, on August 30: T. **Thorp**.—Inaugural address: the **President** (see p. 637).

PARIS.

Academy of Sciences, October 16.—M. Troost in the chair.—On the absolute desiccation of vegetable products: L. **Maquenne**. It is commonly assumed that when a substance has been heated in an air oven at 100° C. to 120° C. until its weight becomes constant, all the moisture has been driven off. The author shows that this is not the case for substances such as starch and flour. For complete drying, either a current of well dried gas must be passed over the starch at about 120° C., or it must be sealed up in a vacuum with a dehydrating agent for a long period.—Presentation of the twelfth volume of the "Mémorial du Dépôt général de la Guerre": Bouquet **de la Grye**. This volume includes the measurements of the new meridian of France from the bases of Paris, Perpignan, and Cassel. Attention is directed to the accuracy of the results obtained.—Preliminary note on the observation of the total solar eclipse of August 30 made at Guelma: MM. **Bourget** and **Montangerand**. Fifteen photographs were obtained during totality, different coloured screens being interposed. The plates are all good, and show excellent images of the corona and protuberances.—Observations on the total eclipse of the sun of August 30: J. Comas **Solá**. The observations, which were made at Vinaroz, included three photographs of the corona and of the spectra of the chromosphere.—On functions having a finite number of branches: Georges **Rémoundos**.—On the calculation of an arch in masonry: M. **Auric**.—On a phenomenon of cooling observed in silver wires plunged into water and through which electric currents are passing: E. **Rogovsky**. It is shown that the resistance of the wire depends on the magnitude of the current passing through it, this effect being due to the fact that all parts of the wire are not, under these conditions, at the same temperature. It is necessary, to obtain exact values of the resistance of wires in a liquid at the temperature of this liquid, to extrapolate from a series of observations made with different intensities of current.—On the forms of lightning conductors: G. M. **Stanoïévitch**.—The basic character of pyranic oxygen. Halogen compounds of dinaphthopyryl with metals and metalloids: R. **Fosse** and L. **Lesage**. The radical dinaphthopyryl, $-CH\langle{}^{C_{10}H_6}_{C_{10}H_6}\rangle O$, although not containing nitrogen, forms a large number of double salts, examples of which with platinum, lead, iron, zinc, tin, bismuth, arsenic, and antimony are given in the present note.—On the development of amylase during the germination of seeds: Jean **Effront**. The sugar-forming and liquefying powers of malt do not develop at the same rate during germination, the former being the more rapid and reaching a maximum, whilst the latter steadily increases with the time of germination.—The measurement of the mechanical work obtainable from Limousin cattle: M. **Ringelmann**.—On a new flagellated parasite of *Bombyx mori* (*Herpetomonas bombycis*): C. **Levaditi**.

NEW SOUTH WALES.

Royal Society, September 6.—Mr. H. A. Lenehan, president, in the chair.—Reinforced concrete, paper iii.: Prof. W. H. **Warren**. The following matters were dealt with:—(*a*) The adhesion of cement mortar and concrete to steel. (*b*) The experimental determination of the neutral axis in a plain concrete, and also in a reinforced concrete beam, and the curves of strain for loads increasing from zero to the load producing fracture; the determination of the true form of the stress curve from the actual strain curve in a plain and in a reinforced concrete beam. (*c*) The safe working stresses and the fundamental equations recommended for the design of reinforced concrete structure.—The occurrence of inclusions of basic plutonic rocks in a dyke near Kiama: C. A. **Sussmilch**.

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 27.

PHYSICAL SOCIETY, at 5.—The Theory of Phasemeters: Dr. W. E. Sumpner.—Apparatus designed for measuring the Coronal Radiation during an Eclipse: Prof. H. L. Callendar, F.R.S.

SATURDAY, OCTOBER 28.

THE ESSEX FIELD CLUB, at 6.30 (at the Essex Museum of Natural History, Stratford).—Straw-Plaiting; a Lost Essex Industry: J. Chalkley Gould.

TUESDAY, OCTOBER 31.

FARADAY SOCIETY, at 8.—*Discussion*.—Alternate Current Electrolysis: Prof. Ernest Wilson.—Alternate Current Electrolysis as shown by Oscillograph Records: W. R. Cooper.—Note on the Crystalline Structure of Electro-deposited Copper: Prof. A. K. Huntington.—Some Observations Respecting the Relation of Stability to Electrochemical Efficiency in Hypochlorite Production: W. Pollard Digby.

WEDNESDAY, NOVEMBER 1.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.—(1) A Rapid Method for the Determination of Tin in Copper-Tin Alloy; (2) Water from the Simplon Tunnel: A. G. Levy.—Notes on (1) Dika Oil; (2) Surin Fat: J. Lewkowitsch.—The Determination of Oxygen in Copper: L. Archbutt.

THURSDAY, NOVEMBER 2.

CHEMICAL SOCIETY, at 8.30.—Solution and Pseudo-solution, part iv., Some of the Arsenious Properties of Arsenious Sulphide and Ferric Hydrate: E. Linder and H. Picton.—The Molecular Conductivity of Water: P. Blackman.—The Stereoisomerism of Substituted Ammonium Compounds: H. O. Jones.—The Influence of very Strong Electromagnetic Fields on the Spark Spectra of Ruthenium, Rhodium, and Palladium; J. E. Purvis.—Note on the Fluorides of Selenium and Tellurium: E. B. R. Prideaux.—The Constitution of Glutaconic Acid: J. F. Thorpe.—Some Alkyl Derivatives of Glutaconic Acid and of 2:6-Dioxypyridine: H. Baron and J. F. Thorpe.—Note on the Formation of β-Methylglutaconic Acid and of $\alpha\beta$-Dimethylglutaconic Acid: F. V. Darbishire and J. F. Thorpe.

LINNEAN SOCIETY, at 8.—Plant Ecology, interpreted by Direct Response to the Conditions of Life: Rev. G. Henslow.

RÖNTGEN SOCIETY, at 8.15.—The Ruhmkorff Coil: Prof. Wertheim-Salomonson.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Sea Defences: Baron H. T. H. Siccama.

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